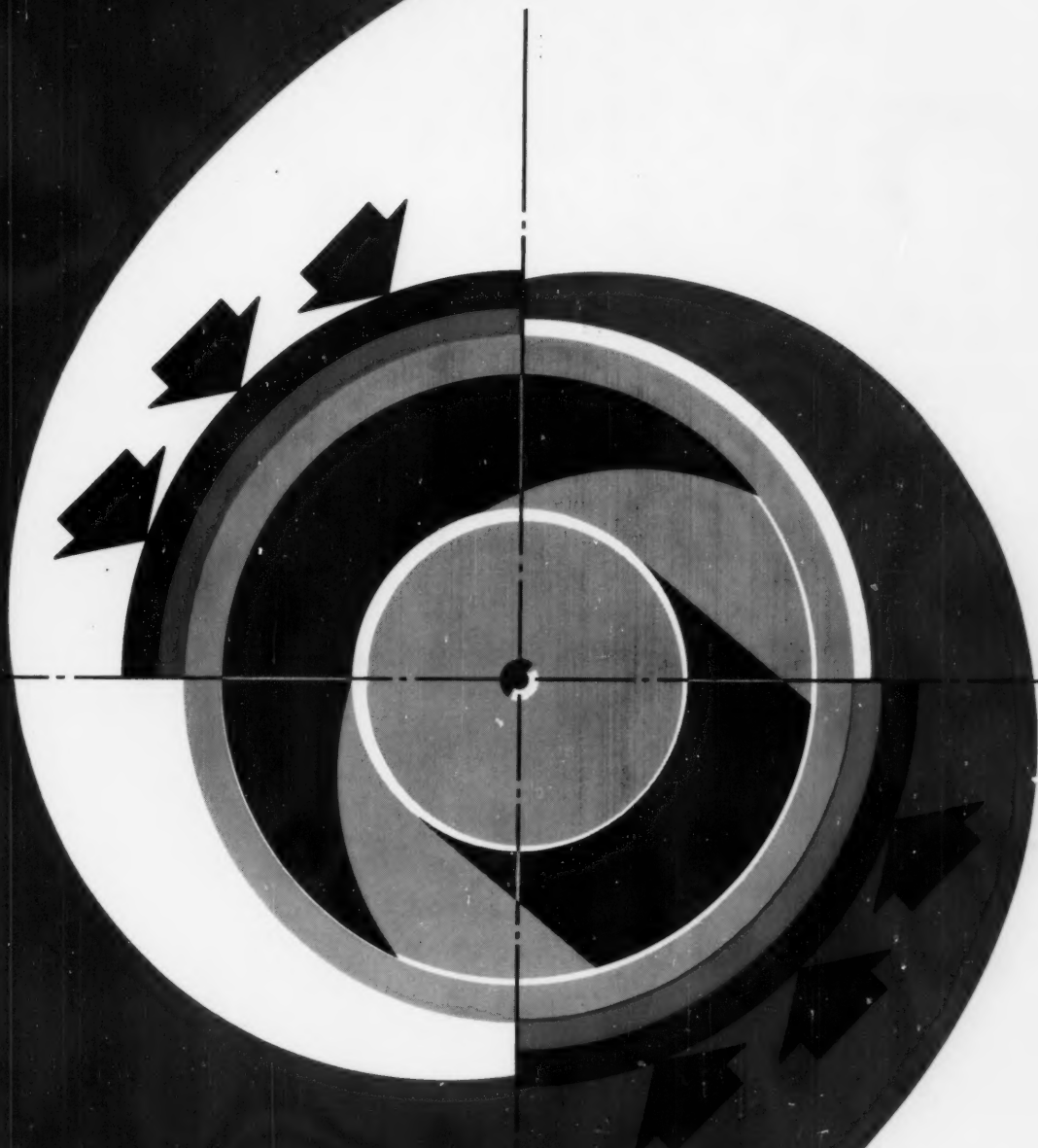


JUNE 23, 1960

MACHINE

DESIGN

A DESIGN PUBLICATION - BIWEEKLY



External-Shoe Brakes

Contents, Page 3

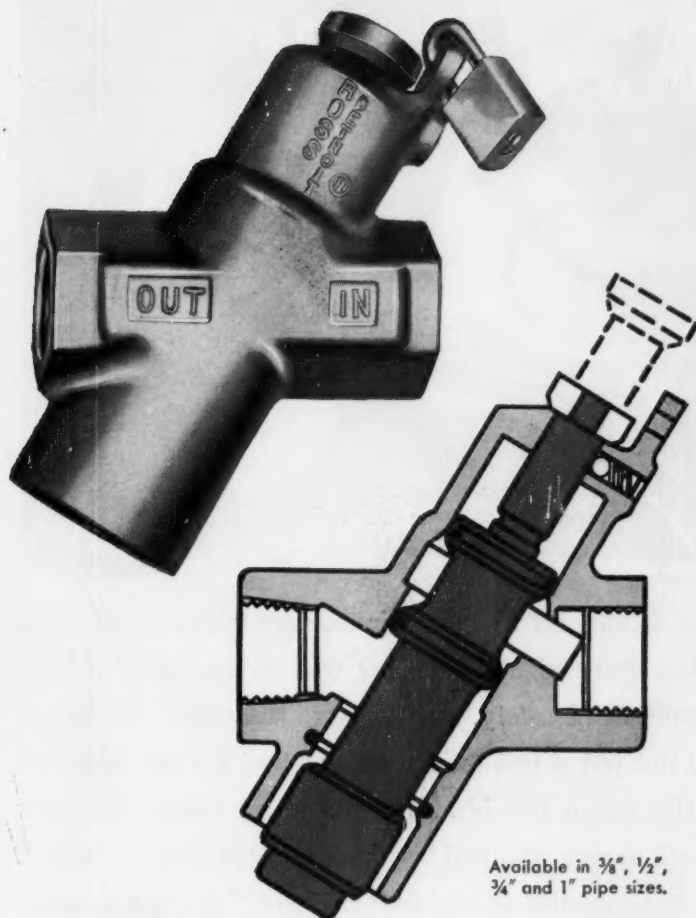


Thousands of ways to cut bearing costs lie in our huge stock of high-precision dies for sintered bronze or iron bearings. The world's largest inventory of dies is ready at an instant's notice to turn out the exact bearings you need . . . without the delay or expense of tooling. One more assurance of the exceptional service you can expect of Bound Brook.

BOUND BROOK

Bound Brook Oil-less Bearing Co., Bound Brook, N. J.
Pioneer in Powder Metallurgy Bearings and Parts.
Plants at Bound Brook, N.J. and Sturgis, Mich.

Lock out air for machine repair



Available in $\frac{3}{8}$ ", $\frac{1}{2}$ ",
 $\frac{3}{4}$ " and 1" pipe sizes.

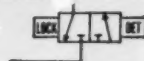
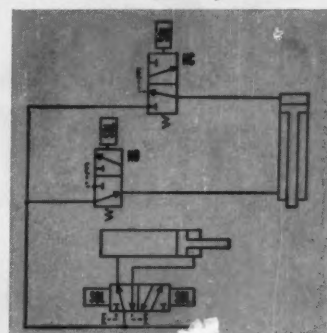
Ross L-O-X VALVE

(Lock—Out—eXhaust)

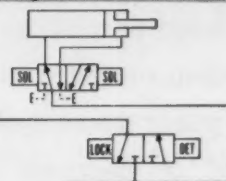
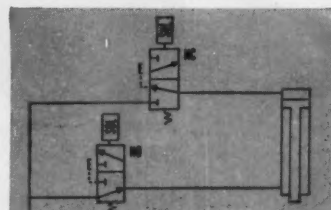
Now you can actually lock out air that operates a machine, as a safeguard when making machine repairs. The Ross L-O-X Valve installs in the supply line leading to the machine, upstream of any operating valve. It is so designed that when closed, supply-air to the machine is shut off and air downstream is exhausted. The valve can be *padlocked* in this position.

More L-O-X valves can be incorporated in the circuit to shut off and exhaust various segments of the circuit. Thus portions of the circuit can be available for maintenance service without shutting down the entire circuit. Detented in the open position, designed for very low pressure drop. Lightweight aluminum construction. Call your Ross representative or write for literature.

(AIR LOCKED OUT FROM
SHADED AREA OF CIRCUIT)



Use the L-O-X valve to shut
down an entire air circuit...

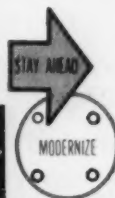


...or use it to shut down
just a portion of the circuit.

ROSS

OPERATING VALVE COMPANY

109 EAST GOLDEN GATE AVE. • DETROIT 3, MICH.



planning and doing

the MICE in COUNCIL



One night the mice held a meeting to decide how to end their troubles with the cat. She never failed to take one or two of them every night, and they were desperate. // Many plans were suggested to solve their problem of safety, but all were discarded. At last a smart young mouse spoke up: "Why not put a bell on the cat, so that we can hear her coming?" // Everyone thought that this was a fine idea, and the young mouse was very pleased with himself. Then a shrewd old mouse, who had kept quiet up till then, remarked, "Indeed a good solution, but who will hang the bell around the cat's neck?" // Not a mouse spoke a word. One by one they crept away. The meeting was over.

moral: Not just planning - but doing - brings most profitable rewards.

Planning and doing are very different things. The manufacturer who *plans* to design machines that will accommodate standard stock cylinders has a good idea. The manufacturer who *does* design standard stock cylinders into his machines sees his good idea cut production costs, earn a lower cost per unit . . . and increase profits.

You can earn profitable rewards using Hydro-Line standard stock cylinders. They have all catalog stock dimensions, cost

10% less than custom cylinders, and are delivered quickly. Of course, your order for modified cylinder designs also will receive prompt attention.

Either way, anticipate your cylinder requirements during the machine-design stage. Look in *Sweet's Product Design File* (Bulletin 8a/Hy) for standard dimensions of stock cylinders and the address of your nearest Hydro-Line representative. Then ask him for the best cylinder for your particular application.



**HYDRO-LINE
CYLINDERS**



5600 PIKE ROAD • ROCKFORD, ILLINOIS manufacturers of: high- and low-pressure hydraulic cylinders • heavy-duty air cylinders • adjustable-stroke cylinders • dispensing cylinders • intensifiers • single-acting cylinders • booster cylinders



Front Cover: Freezing motion is no problem for artist George Farnsworth as he "puts on the brakes" to stop the drum of his simple external-shoe brake design. Inspiration for the cover theme was provided by H. A. Borchardt's article on brake design, Page 163.

June 23, 1960

The Technician: Engineering Semipro? 25

News Report—Part 4: Hiring (and Keeping) the Good Ones—Techniques used by management to get good technicians and to keep them happy on the job.

Toughening the Dry-Film Lubes 30

News Report—Ball bearings coated with new inorganic films containing lubricating solids show promising results for operation at extreme temperatures.

Pneumatic-Power Systems 120

I. LEONARD KAPLAN—Part 1: Applications and Component Selection—Common functions performed by air-power circuits and basic components used in their design.

Patent Owners' Rights 125

ALBERT WOODRUFF GRAY—How the courts define the extent of protection provided the owner of a patent against infringement of his legal rights.

Beta Titanium 132

E. F. ERBIN—Design properties and fabrication characteristics of a heat-treatable titanium alloy that is far superior to steel on a strength-to-weight basis.

Static-Control Shift Registers 140

E. L. RUDISILL—Two basic types of circuits using logic-function devices for reliable control of sequential, random, or evenly spaced machine and processing operations.

Thermal Stresses in Design 153

S. S. MANSON—Part 18: Working Stresses for Ductile Materials—Methods for determining total strain range in parts subjected to thermal cycling but not to external load.

Equivalent Spring Mass 160

FERDINAND FREUDENSTEIN—How to find the equivalent form of spring-mass combinations for simplified analysis of system vibration.

Brakes 163

H. A. BORCHARDT—Data Sheet—A graphical method for estimating dimensions and determining operating limits of brake drums in external-shoe brake assemblies.

Electrical Contacts 170

CHILDRESS B. GWYN Jr.—Design Abstracts—A survey of contact materials, their physical characteristics, and the factors that influence their selection in design.

CONTINUED NEXT PAGE

The 1960 Crop 119

COLIN CARMICHAEL—Editorial

Engineering News 6

Airless metal-working plant 6	Photo-mechanical stamping 32
Computer-tested trucks 8	Transistor-controlled motor 32
Roll-chain drive 10	Plastic troubles 34
Lathe with a memory 12	Ultrasonic machining 36
Two-cycle engines 14	Ceramic gyro 39
Inventions wanted 14	AGMA award 42
Trends 22	
Meetings and Shows 42	
Short Courses and Symposia 45	

Scanning the Field for Ideas 127

Light-beam varies speed of tape-winding motor—magnetic repulsion provides frictionless thrust bearing—shaft deflection regulates flow valve—magnetostrictive capacitor and a coil form oscillating circuit—flat-groove ball races permit lateral motion of cabinet slides—actuating card operates spring contacts—conductive plastic provides low-friction surface—twin bulbs and prism provide dual color indication.

Design in Action 145

Mechanical egg blower eliminates hand opening—lightweight cleaner converts to washer—impact energy of rail-spike hammer is doubled by storage springs—A-frame regulator maintains tension on control cables in multijet liner—mechanical integrator operates on electric function.

Tips and Techniques

Reference cabinet 124	Reference shelf 162
Torsional stiffness 124	Tape dispenser 162
Adding degrees and minutes 159	Conversion of co-ordinates.. 169
LeRoy circles and ellipses 169	

Design Abstracts 170

New Parts and Materials 190

Engineering Department Equipment 238

The Engineer's Library 242

Noteworthy Patents 246

Backtalk 260

Helpful Literature 182

Subject Index 17	Advertising Index 259
Reader Service Cards 19	Business Staff 259

IN THE NEXT ISSUE: Ships that ride on air . . . engineering administration . . . magnetic mockups . . . pneumatic-power systems . . . powder-metal parts . . . critical damping ratio of flat plates and panels . . . cyclic life for ductile materials . . . planetary drives.

Publisher
ROBERT L. HARTFORD

Editor
COLIN CARMICHAEL

Associate Managing Editors
BENJAMIN L. HUMMEL
ROBERT L. STEDFELD

Associate Editors
LEO F. SPECTOR
WILLIAM S. MILLER
SPENCER R. GRIFFITH
JAMES A. PARKS
MELVIN E. LONG
JESSE W. HUCKERT

Assistant Editors
CLARE E. WISE
THEODORE M. LEACH
STANLEY G. COOK
RICHARD A. JACOBSON
JOHN J. HOSTAK
DONALD R. DREGER
JAMES J. BUNTING
JANE H. SMITH
MARIAN L. EICHAR

Art Editors
FRANK H. BURGESS
ROBERT L. TUFTS

EDITORIAL OFFICES
Penton Building, Cleveland 13, Ohio

Branch Offices
New York, Detroit, Chicago, Pittsburgh,
Washington, London



©1960 by The Penton Publishing Co.
All rights reserved.

MACHINE DESIGN is sent at no cost to management, design and engineering personnel whose work involves design engineering of machines, appliances, electrical and mechanical equipment, in U. S. and Canadian companies employing 20 or more people. Copies are sent on the basis of one for each group of four or five readers. Consulting and industrial engineering firms, research institutions and U. S. government installations, performing design engineering of products are also eligible.

Subscription in United States, possessions, and Canada for home-addressed copies and copies not qualified under above rules: One year, \$10. Single copies \$1.00. Other countries: One year, \$25. When requesting changes of address, etc., please allow four to six weeks for processing.

Published every other Thursday by The Penton Publishing Co., Penton Bldg., Cleveland 13, Ohio. Accepted as Controlled Circulation publication at Cleveland, Ohio.

NEW IDEAS IN COPPER ALLOY ROD AND WIRE

Interesting things happen when you add a spot of zirconium or chromium to copper—four high-conductivity coppers that boost production, cut cost of machining—even plain old free-cutting brass rod is going fancy.

There's a quiet revolution going on in copper metallurgy. Research and development teams are expanding the useful knowledge of copper and copper alloys in an effort to define the properties most suitable for specific engineering applications.

STABILITY at elevated temperature, combined with good electrical conductivity, is probably a combination most sought after by design engineers and by our industry's research teams. Two alloys are now commercially available, and the alloy systems are unique. Chromium copper and zirconium copper are heat-treatable alloys with good stability of mechanical properties up to temperatures in the order of 600 F.

CHROMIUM copper in the fully heat-treated condition following a solution anneal will exhibit properties combining a tensile strength of about 75,000 psi with conductivity of approximately 80% IACS. Zirconium copper has good stability characteristics at elevated temperatures and conductivity of 90 to 95% IACS; the strength properties developed by heat treating are, however, somewhat lower than chromium copper.

SEVERAL other heat-treatable copper alloys with intermediate properties are gaining recognition in the connector and electronics fields. These alloys fall into a conductivity range of 35 to 65% IACS, with tensile strengths 90,000 to 100,000 psi. The most popular alloy systems are the copper-nickel-phosphorus and copper-nickel-silicon series with modifications for free machining or other specific requirements. These alloys have a solution annealing temperature about 100 to 200 C lower than the chromium and zirconium coppers.

THE WIDESPREAD use of panel or harness construction for linking segments of electrical control devices has made the requirement for free-cutting coppers mandatory. Screw machine shops are fabricating these connector components of various designs by the millions. Currently the most popular free-

cutting coppers are leaded copper with conductivity of about 98% IACS, and tellurium and sulfur coppers at about 95% IACS. Some of these free-cutting coppers have residual oxygen and can become brittle or gassed under the usual conditions contributing to this phenomenon. All, however, can be obtained with a combination of deoxidizers or oxygen-free copper. In the case of the deoxidized variety, some slight sacrifice in conductivity will be noticed. Ordinary usage very seldom requires conductivity in excess of 90% IACS—and this presents no problem for these coppers.

ALL of these coppers can be cold worked without too much trouble. They can be supplied in a suitable wire temper for cold heading and secondary operations designed around the basic alloy system. Up to now there has not been too much interest in these alloys for wire forming or heading operations. Close dimensional tolerances may be the reason for the reluctance of the heading people to get into the electrical connector business. Alloys are available with the ductility and mechanical properties necessary for this type of forming. It would appear that some of the products could be made more economically by cold-heading or wire-forming operations.

RECENT TRENDS have also affected the old brass and copper reliables. There can't be any product more prosaic than free-cutting brass rod; it is the cheapest of such commodities and at one time was the easiest to process—all one had to do was to extrude, draw to finish dimensions, and ship. In many cases this practice won't work today. Deep drilling, roll threading, knurling, staking, slotting, etc., have complicated the picture, but the latest efforts of the screw machine builders have laid this ghost to rest. We now hear of beta-free rod for close tolerances on deep-drilling applications. Similar grain structures, but not necessarily the same temper, are required for roll thread-

ing, knurling and staking or whenever extra ductility is needed. Along with the consideration of grain structure, it has been necessary to take advantage of the broad chemical composition range for free-cutting brass. Most suppliers divide the standard range into two parts, utilizing the lower copper range for the larger sizes that will normally be machined on the heavier, faster screw machines where chip breaking and clearing the tools are the most important considerations. This might be considered the rough, breakdown type of stock.

FOR the smaller diameters, specialization has been the watchword. Depending on specific needs, you can now obtain free-cutting brass rod with all-alpha, fine-grained structure or an alpha-beta fine-grained extruded structure, or possibly a combination of both. For certain applications you might need a coarse-grained, all-alpha structure. Lead dispersion and lead content are other variables that can and will be controlled to meet fabricating or end-use requirements.

IN the cold-heading industry, advantage is being taken of the wider selection of copper and copper alloys that is available today. The nickel silvers, phosphor bronzes, and silicon bronzes combine good ductility and high strength with excellent corrosion resistance. The whole range of common brasses has specific applications and can be tailored to various heading operations.

The research and development hopper is full of interesting new ideas and projects at The American Brass Company. It could be that we're working on something which would help solve one of your problems. Even though we don't have the complete answer, perhaps we could both reach a solution faster by pooling our efforts. Call your American Brass representative and talk it over with him or write: Manager, Market Planning, The American Brass Company, Waterbury 20, Conn.

ANACONDA®

**COPPER — BRASS — BRONZE
NICKEL SILVER MILL PRODUCTS**

*Made by
The American Brass Company*

ENGINEERING NEWS

Refractory Metals Shape Up in Room Full of Argon

**Complete Metalworking Facilities
Occupy Spacious Inert Lodgings**

BRIDGEVILLE, PA.—Exotic metals like molybdenum and columbium are now being processed in a completely oxygen-free facility. When worked in air, some refractory metals oxidize catastrophically, usually far below their best hot-working temperatures. To stop contamination and upgrade the metals, an all-welded steel room, twice as big as a house, surrounds a complete fabricating facility with an atmosphere of pure argon.

Designed and constructed by Universal-Cyclops Corp. with the aid of the Navy Dept., the facility enables refractory metals to be hot-worked at 4500 F—double the temperature possible in previous furnaces. A specially built rolling mill, forging impactor, and a 10-ton crane can be operated remotely from a console outside the room, or inside by a space-suited technician.

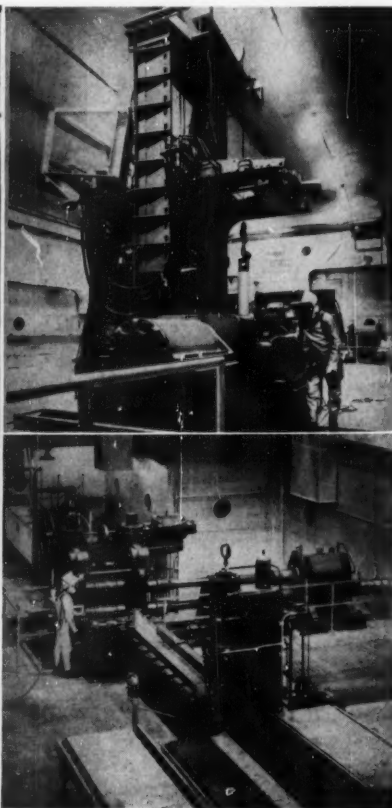
The high-purity atmosphere is safeguarded by air-locks through which everything entering or leaving the room must pass. After personnel enter and lock the outer door,

nitrogen flushes the air from the lock. Argon replaces the nitrogen, and the inner door is opened. Personnel entry takes three to five minutes. Materials, however, are transferred more quickly. Once they are in the lock, air is evacuated and immediately replaced with argon.

Because of the immense quantities of heat generated within the facility, an argon-purifier unit provides refrigeration. Argon, removed at 120 F, is returned at 30 F to maintain room temperature at 80 to 100 F. Argon purity will be held at a level exceeding 99.995 per cent.



Pulling stock into an airless room, a technician carries his own oxygen and cooling system. The room—filled with argon—is to be used for processing refractory metals. The technician wears a four-layer pressure suit which shields him from thermal and ultraviolet radiation. Anything moving in or out of the facility, like the molybdenum electrode



(left), goes through air locks. The metal is heated in a high-frequency induction furnace located immediately beneath an argon-operated impactor (top, right). All equipment, including the rolling mill (bottom, right), can be operated either from a console outside the facility or by the technician inside. Contact is maintained by telephone.

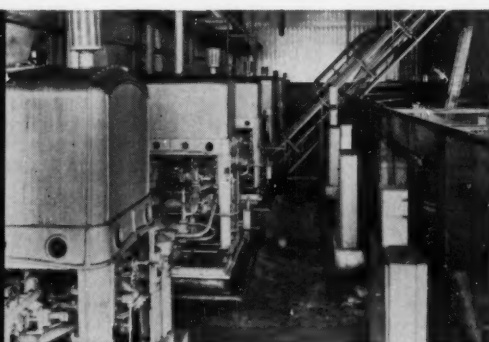
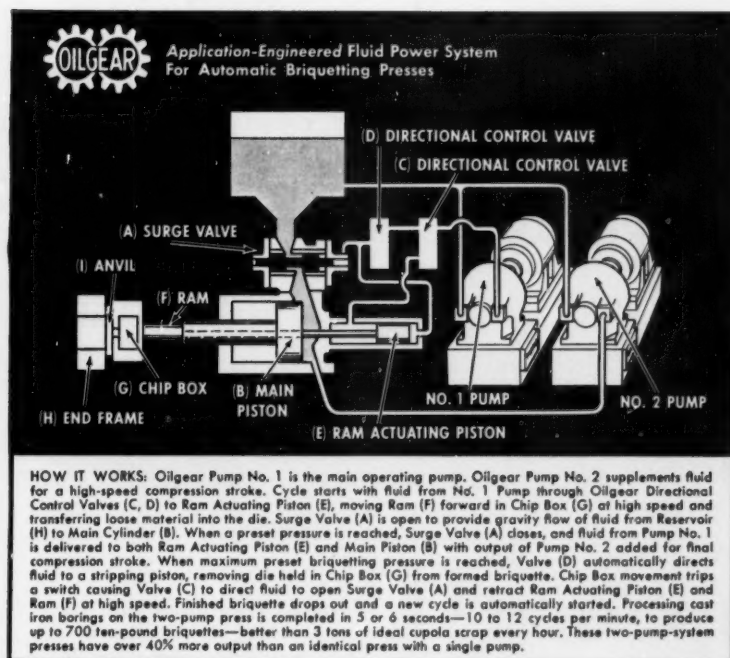
From Oilgear Application-Engineering Files

HOW OILGEAR-EQUIPPED BRIQUETTING PRESSES PRODUCE MORE—LONGER—AUTOMATICALLY

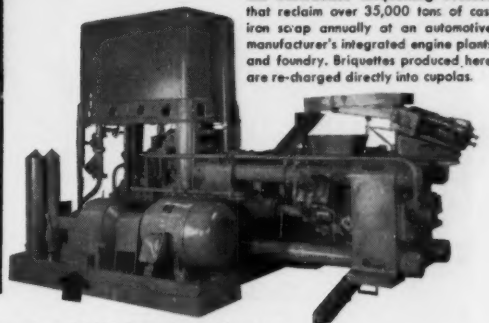
CUSTOMER: Milwaukee Foundry Equipment Division of SPO Inc.

DATA: To power a line of presses specially designed for low cost, rapid conversion of bulky, low-grade metal turnings and borings into dense, uniform-sized briquettes to: conserve storage space; simplify handling; prevent storage oxidation—particularly with finely divided metals or sponge iron; provide sufficient density and size to melt rather than flash into oxide on entry into foundry cupola; control metal content; provide a simple means of accurate compounding for alloying or supplying a flux.

PRESS SYSTEM REQUIREMENTS: 1. Eliminate wear and maintenance costs resulting from use of gears and bearings. 2. To be controlled hydraulically, electrically, or electrohydraulically for automatic cycling at rates ranging from 9 to 17 strokes per minute. 3. Sufficient force to provide briquette densities of 70 to 80% with conservative pump loading. 4. Long life, rugged dependability . . . capable of years of continuous operation with an absolute minimum of maintenance.



Six Milwaukee Briquetting Presses that reclaim over 35,000 tons of cast iron scrap annually at an automotive manufacturer's integrated engine plants and foundry. Briquettes produced here are re-charged directly into cupolas.



One of the two Oilgear Type "C-60" Pumps indicated on a 350-ton Milwaukee Briquetting Press. Note how briquettes roll out of the press to be picked up by magnets.

SOLUTION: Oilgear Application-Engineered systems consisting of Oilgear Type "C" Heavy-Duty Constant Displacement Radial Rolling Piston Pumps and Directional Control Valves. Pump requirements range from 23 gpm on the 75-ton Presses to 325 gpm on new 1000-ton presses. Milwaukee Foundry Equipment—builder of over 80% of all briquetting presses, and an exclusive user of Oilgear Fluid Power Systems since 1927—recently reported: "We just modernized a press that had been in continuous cast iron briquetting operation for over 18 years . . . there had been no reported major maintenance . . . the Oilgear components still operated fine—with no appreciable signs of wear or loss in efficiency."

This is just one evidence—out of hundreds—of the long service life of Oilgear Systems. Ten or more years of continuous service is common with Oilgear equipment, rather than the exception . . . with many of these systems operating under adverse conditions—rapid cycling, grit-laden air, heat, and extreme humidity. Where the going is toughest—Oilgear Pumps just keep rolling along . . . quietly, efficiently.

With Oilgear Heavy-Duty System Components designed for thousands of hours of continuous service at full rated load, savings are compounded with every hour of uninterrupted performance. That's why machinery and equipment manufacturers and their customers say . . .

"for the lowest cost per year . . . it's Oilgear!"

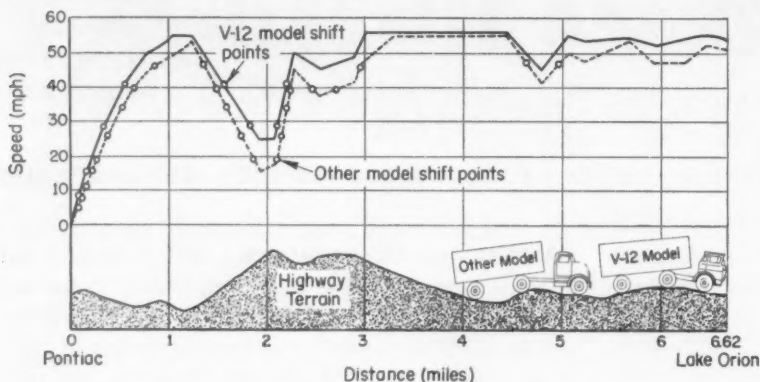
For solutions to YOUR linear or rotary Controlled Motion problems, call the factory-trained Oilgear Application-Engineer in your vicinity. Or write, stating your specific requirements, directly to . . .

THE OILGEAR COMPANY

Application-Engineered Controlled Motion Systems

1568 WEST PIERCE STREET • MILWAUKEE 4, WISCONSIN

Phone: Mitchell 5-6715 . . . Direct Distance Dialing Code 414



Trucks "Road Tested" by Computer

Within minutes of completing engineering specifications for a proposed truck, designers can graph and examine performance facts. Using a medium-sized digital computer, General Motors Corp., Pontiac, Mich. charts the progress of a hypothetical truck over a prescribed route. The machine calculates trip time, fuel usage, and other factors to an accuracy of one per cent. Recently, GM engineers compared the performance of their new V-12 with an outmoded in-line "six" on a paper test route from Pontiac to Lake Orion. The computer showed that the V-12 was 10.7 per cent faster, 1.6 per cent more economical on fuel, and required 65 per cent less shifting. Results were confirmed by road tests.



Compass Comparator Sees Double

Keeping an eye on simultaneous events leads to headaches unless you develop a tool to do the watching. Engineers at the Boeing Transport Div., Renton, Wash., did just that to check out the dual-compass system on the Boeing 707 and 720 jetliners. Their new comparator—an electromechanical device with split-vision versatility—monitors the two compasses and records variations to within 0.2 degree (0.1 degree is possible with a correction chart). On its second recorder, the comparator graphs headings from one compass to provide a reference for post-flight analysis and adjustment. Servo-repeaters translate compass readings into shaft rotations which drive a differential potentiometer. Other applications for the new instrument are also being studied.

Topics

A boat that swims like a fish—by wriggling through the water—has been patented. The speedboat travels mostly submerged and is propelled by oscillations of its rubber-covered, spring-filled tail. An electric motor puts the wiggle in the tail.

Small cars are a pain in the neck. At least they can cause such pains, says a Chicago physician. Aches in the chest, back, and hips are blamed on small driving quarters and the difficulty of getting in and out, constant shifting of gears, and absence of power assists on the sports models. The bursitis-like maladies are not confined to big people either—the average (size) man who owns a sports car is susceptible too.

Sheepskins and shekels: June 1960 engineering and scientific graduates are being offered starting salaries 5 per cent higher than last year's graduates. Campus recruiting also increased this year—about 10 per cent over 1959.

Do-it-yourself in orbit: Robots that repair their equipment—and each other—will be crew members of future space vehicles. So says Dr. Fred L. Whipple, head of Harvard's astronomy department and director of the Smithsonian Astrophysical Observatory at Cambridge, Mass. Dr. Whipple believes that space robots, controlled by earthbound television, would assure reliability of equipment, which is a major problem of space exploration. Sending robots instead of humans into space would also cut down on expenses, weight, and "emotional concern."

People on space flights may wish to travel entranced, according to a UCLA psychologist. Prof. Roy M. Dorcus, speaking at a symposium on the psychophysiological aspects of space flight, said that self-induced hypnosis might be a means of reducing boredom and implanting thoughts to dispel anxiety.

Reactor operation may take its place as the fourth "R" in college programs, thanks to a new laboratory model with a "university budget" price tag. Developed by the Atomics International Div. of North American Aviation Inc., a nuclear reactor of the boiling-water type fits into a 20 by 20-ft room and requires no extensive modifications to the building in which it is housed. Cost is around \$100,000.


FOR RELIABILITY UNDER SHOCK LOADS AND HIGH HEAT...SPECIFY MIDVAC STEELS

Where metal parts must stand the sudden shock of heavy loads, as on plane landing gears . . . or the high heat of jet engines Midvac Steels offer the answer. The Midvac Process of consumable electrode vacuum melting produces metals with increased tensile, higher impact properties, improved stress rupture strength at elevated temperatures, and longer fatigue life.

Midvac Steels are offered in many alloys (some are shown in table below) as billets or forgings for the production of forgings to meet the most critical design specifications of today's space age. Complete details on Midvac Steels, plus comparative analysis of leading super alloys are available in new Midvac Steel Booklet. Write for your copy to . . .

MIDVALE-HEPPENSTALL COMPANY

Subsidiary of Heppenstall Company, Pittsburgh, Pa. NICETOWN, PHILADELPHIA, PA.



Alloy	Melting Process	Yield Strength .2	Ultimate Tensile Strength	Percent Elongation	Percent Reduction of Area
A-286	Air Melt	99,000 psi	132,300 psi	9.0%	14.7%
	Midvac	117,000 psi	150,500 psi	21.3%	33.8%
D6A-C	Air Melt	234,800	281,000	4.9%	20.6%
	Midvac	256,700	294,250	9.6%	28.4%
Tricent	Air Melt	238,600	284,500	6.1%	19.7%
	Midvac	254,300	291,600	10.3%	25.6%
901 Regular	Midvac	116,000	160,000	18.0%	25.0%
901 Hi-Strength	Midvac	131,000	179,000	19.2%	20.2%

Properties shown are averages of 25 heats



Midvac Steels

Roll-Chain Drive

*uses torque-proportional
gripping for
nonslip speed adjustment*

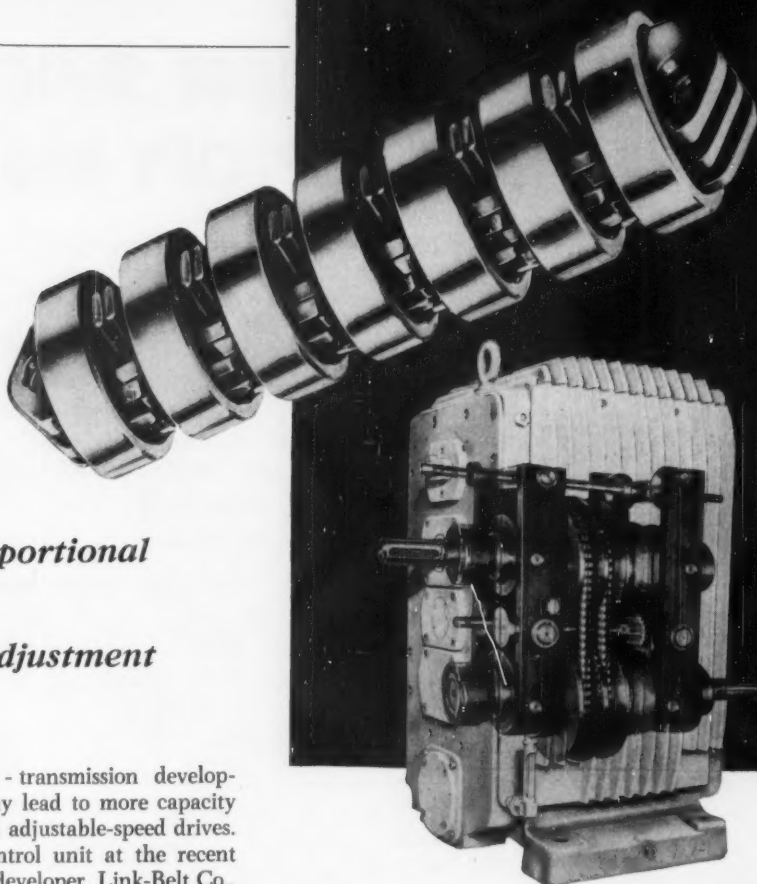
CHICAGO — A unique power-transmission development, the single-roll chain, may lead to more capacity and compactness in mechanical adjustable-speed drives. Demonstrating the stepless control unit at the recent Design Engineering Show, the developer, Link-Belt Co., said that it was aiming at applications in the higher power range (up to 50 hp, with ratios to 5.5:1).

Forming the heart of the drive, roll chains operate in twin strands between adjustable-pitch-diameter pulleys. Each chain "link" consists of a hinged-end center member supporting a roller that rotates laterally. Center members, connected in a continuous loop, transmit chain pull and support side pressures exerted by the adjustable-pitch wheel faces.

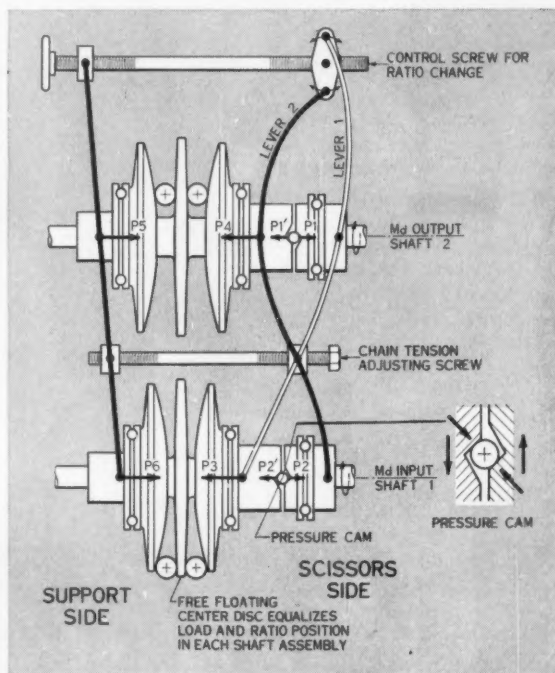
To insure adequate gripping forces between wheel faces and chains, Link-Belt uses pressure cams on both input and output shafts to convert transmitted torque into axial forces. Proportioned and distributed by a compound-lever system, gripping forces acting on each wheel pair are directly related to torque. The arrangement is said to eliminate chain creep or slip throughout the ratio range of the drive.

Built with a selection of speed-variation ratios, the drives are available in five types: Basic drive, basic with output gears, basic with input and output gears, basic with integral foot-type motor, and basic with integral foot-type motor and output gears.

Scissors linkage (levers 1 and 2) in the roll-chain drive proportions and distributes gripping forces to each pair of wheel faces throughout the ratio range. Reaction forces P1 and P2, developed by action of pressure cams on output and input shafts, are carried to opposite wheel faces by the compound-linkage system. Therefore, chain gripping force P4 is the sum of P2 and P1'. Force P3 is the sum of P1 and P2'. A simple adjustment maintains chain tension.

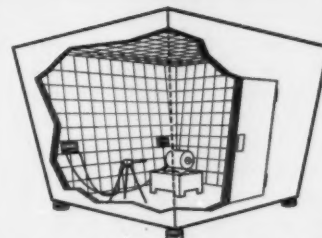


Adjustable-speed drive, designed to give stepless speed control in higher-power applications, uses a unique single-roll chain pair. Short pitch of chains assures smooth meshing action and distribution of load over a greater number of wheel-face-chain contact areas.





PRODUCT INFORMATION



N/D sound booth for analysis of electric motor noise, mounted on springs and constructed with non-parallel walls, assures manufacturers a scientific solution to electric motor noise problems. Motors are tested with special electronic sound evaluation equipment.

How Minimizes Electric Motor Noise!

In New Departure's full-time noise analysis program, a unique sound booth and special electronic sound level equipment are used to pinpoint and evaluate electric motor noise. Inside the booth, a condenser microphone picks up air-borne noise from the running motor. Outside, the signal is electronically registered and recorded.

By changing one variable at a time, such as bearing or mounting design, or lubricant, N/D engineers are able to select the proper com-

bination that results in the quietest motor operation. That's why you'll find New Departure precision ball bearings specified for electric motors to be used in quality home appliances, instruments, fans, hand tools and other applications . . . for greater consumer sales appeal.

If you have an electric motor noise problem, contact the N/D Sales Engineer in your area. For additional information call or write New Departure Division, General Motors Corporation, Bristol, Connecticut.



NEW DEPARTURE
BALL BEARINGS
proved reliability you can build around

Automatic Turret Lathe Learns by Doing

*Machinist Programs Memory
By Cutting First Workpiece*

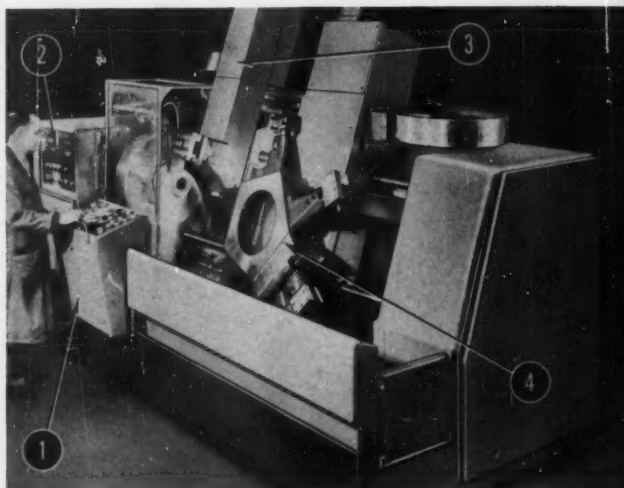
CLEVELAND—New from the floor up, Warner and Swasey's numerically controlled turret lathe needs no external programming. "Taught" by the machinist—who sets up operations for a workpiece by going through one step-by-step cycle manually—the lathe relies on its comprehensive magnetic memory to store and recall commands and imitate, on its own, the operating sequence.

Later, should the program need altering, the machinist can break into the automatic cycle at the proper place and "show" the machine the change. Resetting the entire command sequence is not necessary.

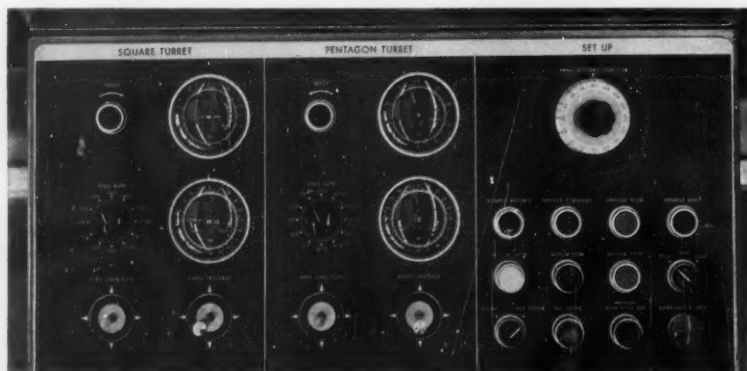
The magnetic memory system (ferrite-core matrix) assimilates up to 96 commands pertaining to feed, speed, start of cut, dimensions, etc. Straight cuts are monitored directly by the memory, but when a contour is desired, the memory switches in a punched-tape system. The cutting tool then follows a series of contour co-ordinates on the tape. Tape-controlled contours are absolutely positioned, and tool drift can't affect the position of the contour on the work.

Quick-change flexibility, W&S points out, gives the setup man the opportunity to make small corrections in final settings for tool deflection and chip action. Modifications in speed and feed rates can be established right at the machine.

Design features of the Servofeed lathe are based on functional needs of numerical control. Bed, bedways, cross slide, saddle, and turret are all inclined rearward 20 degrees from the vertical to give the operator a better view of the work, improve load distribution, and reduce chip stacking. In addition, there are no handwheels or conventional micrometer dials. During setup, all elements are controlled electrically.

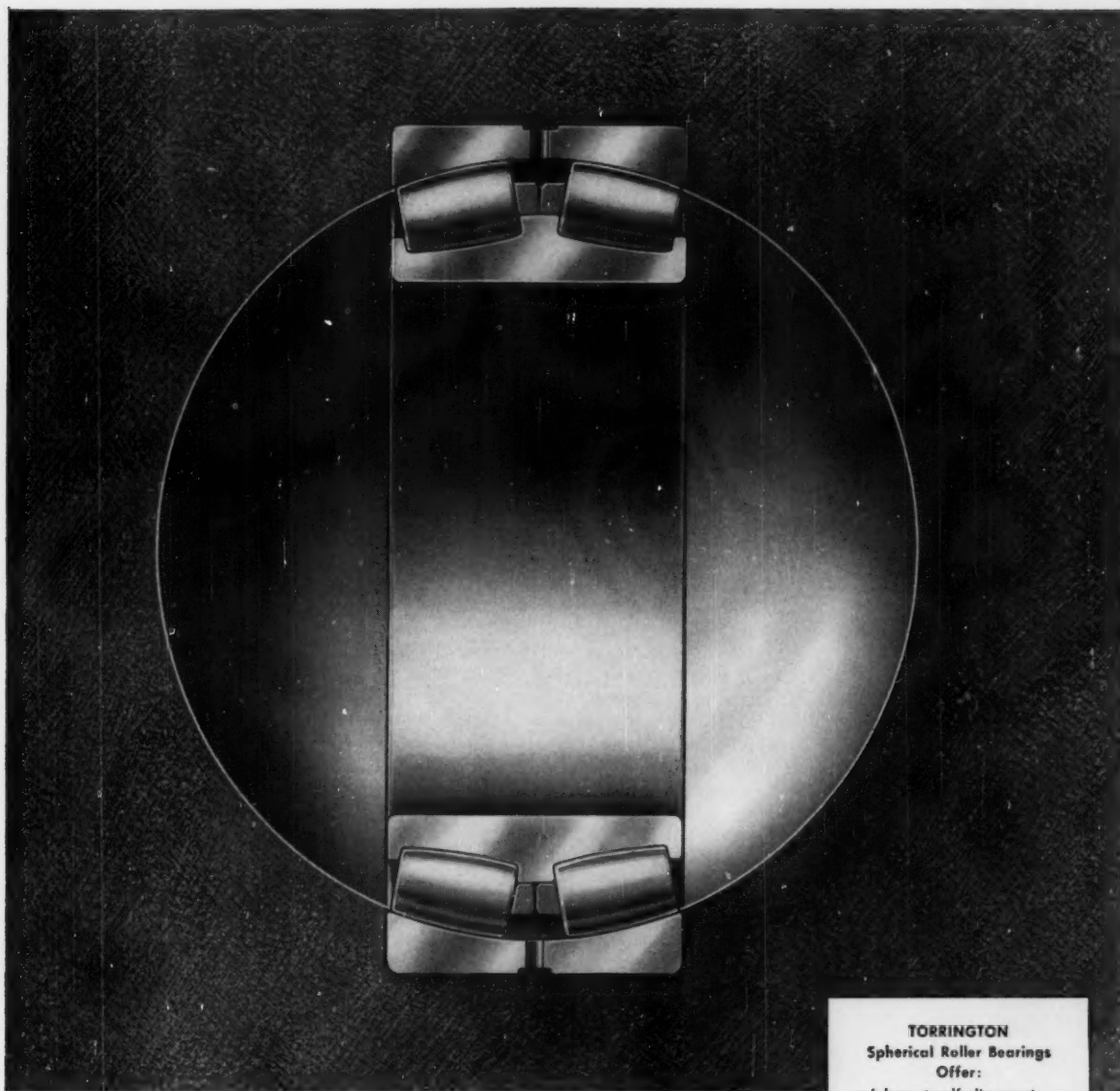


Manually controlled during setup by "joy sticks" and switches on operator's console (1) and headstock panel (2), Warner and Swasey's 25-in. swing automatic turret lathe is programmed by running the cross slide (3) and pentagon (4) through the entire sequence of operations once.



The operator's console (above) moves along the rail to any location so that the machinist can always be on top of the work. Controlling tool advance electrically, he completes an operation on the workpiece, then impresses the details on the lathe's memory by pushing the record button on the headstock panel (below, arrow). When the main memory is controlling automatic operations, the lathe chooses the most efficient cutting path. When the auxiliary punch tape is directing a contour cut (the only operation the punch tape is used for), the lathe has no freedom of choice: It follows the X-Y data on the tape exactly. Able to handle up to 96 separate commands stored on the magnetic memory, the lathe can simultaneously operate the square and pentagon turrets from the same command number. Command corrections or changes are made easily.





IN TORRINGTON SPHERICALS . . . NO COMPROMISE WITH QUALITY

The spherical design concept of Torrington Spherical Roller Bearings means superior performance and outstanding service life under the toughest operating conditions. It means inherent self-alignment, high radial and thrust load capacity, low friction. It allows compensation *within* the bearing for both dynamic and static misalignment.

Roller guidance is positive and accurate . . . is assured by grinding roller ends and center guide flange surfaces to a common spherical radius. Results are truer rolling motion, minimum friction and higher degree of geometric stability. Bearing operation is cooler, quieter, smoother.

If you're looking for outstanding bearing performance and bearing *value*, you should specify Torrington Spherical Roller Bearings. Backed by Torrington's uncompromising experience in engineering and manufacturing every basic type of anti-friction bearing, their quality is unmatched.

TORRINGTON Spherical Roller Bearings Offer:

- inherent self-alignment
- conformity of rollers to raceways
- integral center guide flange for stability
- positive roller guidance
- land-riding bronze cages
- maximum radial and thrust capacity
- controlled internal clearance
- electronically selected rollers
- even load distribution
- long, dependable service life

send for new
Torrington Spherical Roller
Bearing Catalog #258

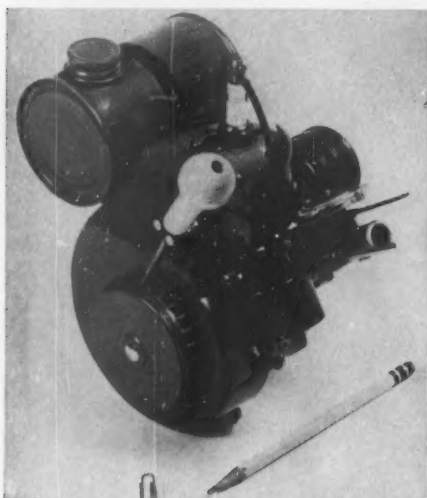
progress through precision

THE TORRINGTON COMPANY

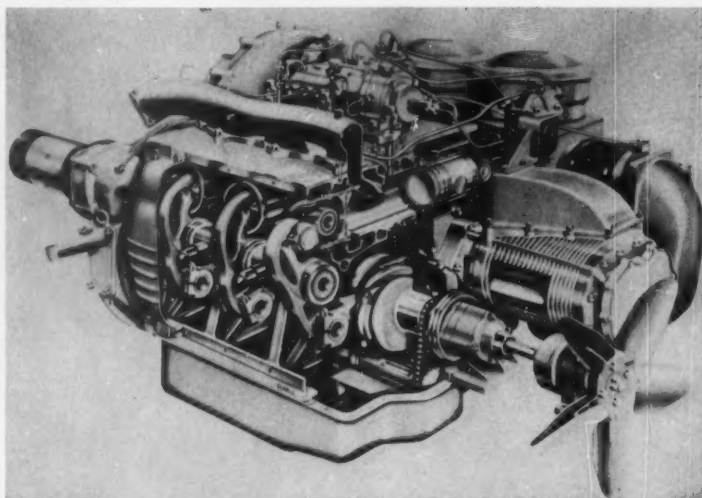
TORRINGTON BEARINGS

South Bend 21, Indiana • Torrington, Conn.

Two Cycles in Two Sizes



Portable household tools and appliances are major applications predicted for a new line of extremely lightweight ($3\frac{3}{4}$ lb) gasoline engines (left). Designed specifically to replace comparable electric motors, the two-cycle powerplants are just $5\frac{3}{4}$ in. in height and come in power ratings of $\frac{1}{2}$ to 1 hp. Operational features include an ultrasensitive throttle governor capable of maintaining nearly constant speed from no load to full load. The governor is set at 6300 rpm—integral gear reducers are available which provide slower shaft speeds. An automatic centrifugal clutch controllable with throttle is also optionally available. The engines will operate at any attitude, were developed by Ohlsson & Rice Inc., Los Angeles.



Designed to run on any type of fuel—even cleaning fluid—a new two-cycle engine (right) developed by England's Roots Motors is suitable for use in cars, trucks, farm machinery, boats, and industrial applications. The basic three-cylinder engine is rated at 105 hp, can be modified to provide 75 and 85-hp ratings. The powerplant's multi-fuel feature (gasoline, diesel oil, kerosene, JP-4) is obtained with a special type of variable-pressure injection system which varies the amount of fuel fed into the combustion chamber depending on the type being used. Prototype of the engine is a diesel unit which has proved itself in millions of miles of service as the standard powerplant in the Roots Commer line of commercial trucks.



Missiles Replace Guns on Largest Carrier

U.S.S. *Kitty Hawk*, the largest aircraft carrier ever built, has propulsion equipment which is lighter and more compact than on World War II ships half its size. The nonnuclear powerplant develops more than 200,000 hp. *Kitty Hawk* has no antiaircraft guns—they have been replaced by guided missiles. Built by New York Shipbuilding Corp., Camden, N. J., the ship has many innovations: A complete air conditioning system, from a 1000-ton unit, and a 500-line fully automatic telephone exchange. The carrier's electric elevators will be able to bring four 40-ton bombers up on deck every minute while the pilots are hurried on deck by electric escalators traveling at 90 ft per min.

NIC Tells How To Submit Ideas to the Armed Forces

Council Acts as Liaison
Between Inventor, Government

WASHINGTON, D. C.—The National Inventors Council seeks "fresh approaches, ideas, and techniques which might lead to superior weapons and equipment" for U. S. military personnel. Problems are supplied by the Army, Navy, and Air Force; solutions sent to the Council are reviewed and, if of potential value, referred to the military.

Questions frequently asked of the Council regarding its "Inventions Wanted" lists are answered in the latest edition. Significant points covered are:

Making Contact: Firms or individuals should communicate directly with the NIC, submitting typewritten (if possible) descriptions in English. Sketches or drawings—

which need not be professional—may supplement written material. This can include: Discussion of principles of the invention; results of experimental work or tests; novel or superior points of the invention, compared to existing devices or techniques. No special forms or legal advice are needed.

Patenting the Invention: Only the U. S. Patent Office can grant patents, and the inventor can, of course, apply for one. Material submitted to the NIC is kept confidential and safeguarded to protect the inventor's rights. Each proposal is date-stamped when received and becomes a part of permanent government records, available as evidence if controversy over the invention ever occurs.

Payment: The Council only evaluates and refers inventions to the services; they, in turn, negotiate with inventors when proposals are accepted.

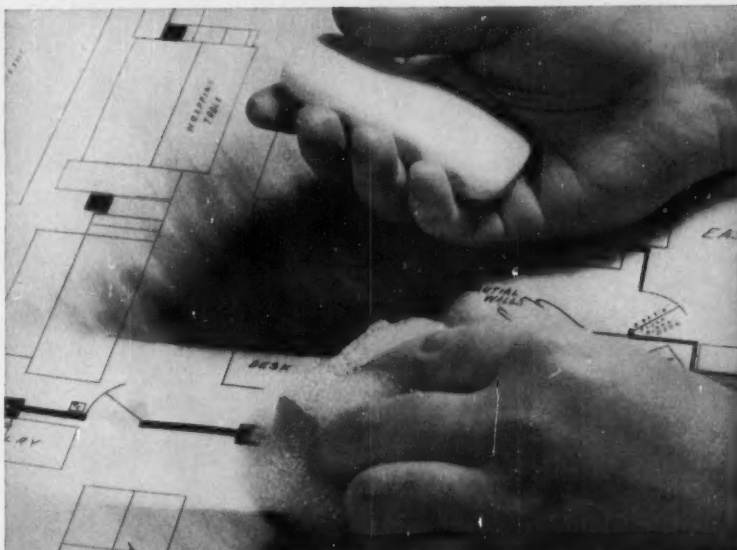
Research Funds: Urgency of the problem, value of the solution, and competence of the submitter govern the granting of funds for development. NIC, however, has nothing to do with the giving of such contracts.

Further Information: The Council is glad to furnish additional data on the problems. It is best that specific questions be asked.

Don't Call Them: Notification on the Council's decision is made as soon as possible—ideally, within a few days of receipt. If the invention is referred to the armed services, the inventor is so informed, and if it is adopted, the service group communicates directly with the inventor. Rejections are handled by the Council. Because all material submitted must be kept for permanent file, duplicate copies should be held by the inventor.

Problems: The new list of military needs covers a range of items from a dumb satellite to a means of underwater target detection. The Council is also interested in ideas not on the list but of value to military agencies or other branches of the government. The complete list, *Inventions Wanted by the Armed Forces*, may be obtained from the National Inventors Council, U. S. Dept. of Commerce, Washington 25, D. C.

DRAFTING TRENDS



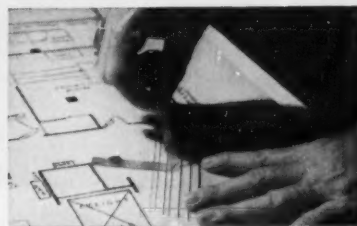
A GLUTTON FOR PUNISHMENT. The image, pencil or ink, on POST Polytex stays put. Won't rub, flake or peel off accidentally, yet can be erased. Duralar pencil lines bond to the surface readily. Soiled originals can be washed with water and detergent!

New POST-perfected Polytex takes pen or pencil perfectly

You already know that drafting films offer the advantages of tremendous durability and dimensional stability. Now, thanks to an exclusive, precision process, POST offers a drafting film with superlative drafting characteristics. The surface of POST 126 Polytex is unmatched for ink receptivity, has a coating that stands up, erasure after erasure. Ink lines won't pull off when cellophane tape is applied firmly over them and then suddenly yanked off. Transparency is excellent.

If you prefer pencil, use a Post Duralar lead for permanence. Plastic-based Duralar lines actually bond themselves to the Polytex surface. Drawings won't easily smudge or smear . . . can even be washed with soap and water.

By using new Polytex, with DuPont Mylar base, you avoid the drawbacks which show up in some



TAPE TEST proves remarkable adhesion of inked lines to the surface of POST 126 Drafting Film, lines which do not feather out or spread.

films . . . a drawing surface too slick to retain a pencil or pen line . . . too soft for use with hard pencil after erasures.

Enjoy the flexibility and long life of a drafting film with an ideal drafting surface. Try new 126 Polytex Drafting Film.

For a test sample and more information, see your local Post Blueprinter, or write Frederick Post Company, 3652 N. Avondale Avenue, Chicago 18, Illinois.



SENSITIZED PAPERS & CLOTHS • TRACING & DRAWING MEDIUMS • DRAWING INSTRUMENTS & SLIDE RULES
ENGINEERING EQUIPMENT & DRAFTING SUPPLIES • FIELD EQUIPMENT & DRAFTING FURNITURE



**NEW
GIANT
AT WORK
on
Double Diamond
Gears**

This huge, continuous, carburizing, hardening and draw furnace now permits even greater instrument control in heat treating **DOUBLE DIAMONDS** for maximum wear resistance and load-carrying capacity. So far as we can discover no more efficient furnace could be installed to achieve the quality characteristics our gear customers have come to expect.

At your request, our gear engineers would be pleased to describe this process in greater detail and to explain, as well, what our recently expanded facilities can mean in terms of this pledge: "**DOUBLE DIAMOND** Gears offer the advantages of lower installed cost and economical and dependable service on the job... gears that do credit to your product and reputation."

EATON

**AUTOMOTIVE GEAR DIVISION
MANUFACTURING COMPANY
RICHMOND, INDIANA**



GEARS FOR AUTOMOTIVE, FARM EQUIPMENT AND GENERAL INDUSTRIAL APPLICATIONS
GEAR-MAKERS TO LEADING MANUFACTURERS



Circle 412 on Page 19

Reader Information Service

SUBJECT INDEX

Editorial and Advertising content classified by subject and listed by page number for convenience when studying specific design problems. For further information on subjects advertised, refer to advertisement and circle Item Number on a Yellow Card—following page.

Actuators, Edit. 197, 252
Adhesives, Edit. 195; Adv. 206, 237
Alloys, high-temperature, Adv. 9, 188, 202
Aluminum and alloys, Adv. 211, 229
Amplifiers, Edit. 129
Axles, Adv. 101

Bearings,
ball, Adv. 11, 104, 171, 196, 220
roller, Adv. 13, 53, 67, 185
sleeve, Edit. 195, 213; Adv. inside front cover, 27, 176, 262
thrust, Edit. 128, 190

Belts,
transmission, Adv. 43, 50, 86, 87
Beta titanium, Edit. 132
Blowers, Edit. 214; Adv. 249
Books, Edit. 242
Brakes, Edit. 163; Adv. 181, 203
Brass (see Copper and alloys)
Bronze (see Copper and alloys)

Capacitors, Edit. 208, 221; Adv. 38
Caps, Adv. 204

Castings,
die, Adv. 46, 107
investment, Adv. 244
iron, Adv. 193, 206
malleable iron, Adv. 102, 103
meehanite, Adv. 97
nonferrous, Adv. 47
steel, Adv. 110

Chain,
conveyor, Adv. 187, 227
transmission, Adv. 49, 189, 191, 199, 254

Clamps, Edit. 190; Adv. 253
Clutches, Edit. 199; Adv. 94, 95, 114, 181, 203, 212, 221, 242, 254

Coatings,
protective, Adv. 237
Cold heading, Adv. 224
Compressors, Adv. 82, 248
Computers, Edit. 152, 176, 238; Adv. back cover

Connectors, electric, Edit. 222; Adv. 256
Contacts, Edit. 131, 170; Adv. 217

Control systems, Edit. 145
electric, Adv. 72, 74
pneumatic Adv. 245
Controls,
electric, Edit. 248; Adv. 207
hydraulic, Edit. 194; Adv. 93
Copper and alloys, Adv. 5
Counters, Edit. 193; Adv. 177, 253
Couplings,
fluid flow, Adv. 257
shaft, Adv. 232

Cylinders,
hydraulic, Edit. 197, 227; Adv. 2, 198, 208
pneumatic, Edit. 197, 227; Adv. 96

Diaphragms, Adv. 179
Dials, Edit. 199
Diodes, Edit. 213
Drafting equipment, Edit. 124, 238, 240; Adv. 15, 33, 92, 223
Drafting techniques, Edit. 169
Drives, adjustable speed, Edit. 222, 234; Adv. 42, 44, 75, 77, 173, 192
Drives, magnetic, Adv. 258

Electric equipment (see specific type)
Electronic equipment, Edit. 32, 127; Adv. 174, 222
Engineering department (see Management or Drafting)
Engineering technician, Edit. 25
Equivalent spring mass, Edit. 160

Fans, Adv. 82, 249
Fasteners,
bolts, studs, screws, Adv. 57, 85, 108, 195, 233, 255
insert, Edit. 212
nuts, Edit. 201; Adv. 48, 118, 219, 234, 252
quick operating, Adv. 85
retaining rings, Adv. 178
rivet, Adv. 219

Finishes (see Coatings)
Fittings, pipe, tube, and hose, Adv. 70, 73, 255

Forgings, Adv. 100, 105
Friction materials, Adv. 71

Gages (see also Instruments)
pressure, Adv. 91, 251
Gaskets, Adv. 112, 115
Gears, Adv. 16, 52, 235, 254, 261

Heaters, Adv. 113, 255
Hose,
nonmetallic, Adv. 240
Hydraulic equipment (see specific type)
Hydraulic fluid, Edit. 198

Increases, speed, Adv. 52
Instruments, Edit. 251; Adv. 175

Jacks, leveling, Adv. 257

Knobs, Edit. 194

Latches, Edit. 209
Lubricants, Edit. 30, 217; Adv. 230

Materials, Edit. 175
Meetings, Edit. 42
Metals (see specific type)
Metalworking equipment, Edit. 148
Meters, Adv. 256
Motors (electric)
fractional and integral hp, Edit. 202, 232; Adv. 29, 51, 61, 76, 80, 106, 116, 178, 184, 192, 205, 212, 224
gearmotors, Adv. 45
subfractional hp, Adv. 184
Motors,
pneumatic, Adv. 186
torque, Edit. 190; Adv. 24, 63, 64
Mountings, vibration and shock, Adv. 60, 216

Nuclear engineering, Edit. 23

Packings, Adv. 27, 35, 59, 115, 200
Patent owners' rights, Edit. 125

SUBJECT INDEX (continued)

Pillow blocks, Adv. 256
 Plastics, Edit. 34, 208, 236; Adv. 68, 69, 239, 243
 molding, Adv. 62
 Plugs, Adv. 204, 238
 Pneumatic equipment (see specific type)
 Potentiometers, Edit. 218, 228
 Power supplies, Edit. 239, 240
 Pumps,
 hydraulic, Edit. 180, 201, 210, 217, 221, 232, 246; Adv. 78, 93, 194, 228, 255
 pneumatic, Adv. 98, 99, 218

Reducers, speed, Edit. 198; Adv. 257, inside back cover

Regulators,
 pressure, Adv. 39, 253
 tension, Edit. 150

Relays, Edit. 130, 227; Adv. 207, 213

Resistors, Edit. 228, 230

Rotary joints, Adv. 58, 65

Rubber, Adv. 50, 231, 250

Seals, Edit. 204; Adv. 35, 59, 81, 200, 204

Shafts, Adv. 37
 flexible, Edit. 231, 250; Adv. 236, 241

Silicones, Adv. 55, 56

Springs, Adv. 63, 64, 111, 222

Stampings, Edit. 32

Static-control shift registers, Edit. 141

Steel, Adv. 9, 21, 88, 89, 105
 stainless, Adv. 36, 37, 109, 195
 strip, Adv. 180

Switches, Edit. 190, 206, 209, 218, 232, 246, 251; Adv. 83, 182, 183, 247, 257, back cover

Systems,
 hydraulic, Edit. 128; Adv. 7, 215
 pneumatic, Edit. 120, 146; Adv. 117

Tachometers, Adv. 201

Tape, Edit. 34

Thermal stresses in design, Edit. 153

Thermocouples, Edit. 179

Thermometers, Adv. 91

Thermostats, Edit. 202, 204; Adv. 66, 84

Timers, Adv. 54, 79, 209, 214

Transducers, Edit. 36

Tubing, Edit. 196; Adv. 21, 109, 210, 225

Universal joints, Adv. 197

Vanadium, Edit. 22

Valves,
 hydraulic, Edit. 190, 205, 224, 230, 250; Adv. 246, 251, 258
 pneumatic, Edit. 205, 210, 230; Adv. 1, 81, 96, 210, 245, 246, 251

Welding, Edit. 177; Adv. 41

Wire and wire products, Adv. 5

Wood, Adv. 90

USE A YELLOW CARD for More Information ...

CIRCLE ITEM NUMBERS—Throughout the magazine, each advertisement carries an Item Number for use in requesting further information. All product descriptions, announcements and Helpful Literature items are also numbered, and for greater convenience are indexed below by Item Numbers.

EDITORIAL CLIPSHEETS—So you won't have to "clip" this issue, we'll be glad to send a personal copy of any article as long as the supply lasts. Just fill in the page number and title of article in the place provided on the Yellow Card.

Index to New Parts & Helpful Literature

BY ITEM NUMBERS

HELPFUL LITERATURE—descriptions start on page 182

ITEM NUMBER	ITEM NUMBER
Bolted Fastener	641
Heavy Tungsten Alloys	642
Pressure-Sensitive Tapes	643
Electronic Hardware and Resistors	644
Copper-Clad Laminates	645
Molded Packing	646
Hydraulic Cylinders	647
Manganese Steel Wear Parts	648
Submersible Sump Pump	649
Plastic Shapes and Parts	650
Induction Motors	651
Magnetic Tape Transports	652
Indexing Components	653
Polyurethane Rigid Foam	654
Motor Operators and Valves	655
Locking Coupling	656
Cast Nonferrous Metals	657
High-Alloy Castings	658
Screws and Spines	659
Footswitches	660
Threaded Inserts	661
Air Equipment	662
Specialty Metals	663
Screws and Bolts	664
RTV Silicone Rubber	665
Stock Springs	666
Refractory Metal Chart	667
Belt Drives	668
Air Cylinders	669
Tubeaxial Fans	670
Aluminum Bearings and Bushings	671
Uses of Tin	672
Fast-Pulse Camera	673
Impulse Counters	674
Precision Gears	675
Slide Assemblies	676
Seals and Fasteners	677
Thin Bearings	678
Screw Thread Root	679
Pressure Regulators	680
Couplings	681
Measuring Instruments	682
Electric Clutches and Brakes	683
Self-Bonding Nameplates	684

NEW PARTS & ENGINEERING EQUIPMENT—descriptions start on page 190

ITEM NUMBER	ITEM NUMBER
Miniature Switch	685
Steel Clips	686
Needle Thrust Bearing	687
Solenoid Valve	688
High-Torque Motor	689
Subminiature Counters	690
Flow-Check Snubber	691
Knobs and Handwheels	692
Contact-Bond Cement	693
Packaged Bearings	694
Expanded Teflon Tubing	695
Power Cylinders	696
Subminiature Actuators	697
Small Speed Reducer	698
Synthetic Oil	699
Drum Dials and Verniers	700
Slip Clutch	701
Self-Locking Nut	702
Miniature Vane Pump	703
Electric Motor	704
Ring Seal	705
Temperature Control	706
Damping Compound	707
Check Valve	708
Snap-Action Switch	709
Rotary Steppers	710
Metalized Paper Capacitors	711
Vinyl Dispersion Resin	712
Container Latch	713
Rotary Switch	714
Air Shuttle Valve	715
Small Fuel Pump	716
Thin-Walled Insert	717
Silicon Diode	718
Bearing Seals	719
Blower Packages	720
Air-Damping Dashpot	721
Self-Wicking Lubricant	722
Canned Pump	723
Trimmer Potentiometers	724
Subminiature Switch	725
Porous-Anode Capacitor	726
Motor-Driven Pump	727
Adjustable-Speed Drive	728
Electrical Interlock	729
PVC Globe Valves	730
Reed Relays	731
Tandem Cylinders	732
Power Resistor	733
Trimmer Potentiometer	734
Explosive-Actuated Valve	735
Wire-Wound Resistors	736
Flexible Shafts	737
Terminal Boards	738
Pump-Motor	739
Switch Assembly	740
Servo-Drive System	741
Oil-Resistant Elastomer	742
Prebonding Compound	743
Arc Ruler	744
Solid-State Calculator	745
DC Power Supply	746
Roll Files	747
Modular Power Supply	748

MACHINE DESIGN **June 23, 1960**

Circle item number for information on products advertised or described or copies of literature.

241	421	451	481	511	541	571	601	631	661	691	721	751	781	811	841
242	422	452	482	512	542	572	602	632	662	692	722	752	782	812	842
243	423	453	483	513	543	573	603	633	663	693	723	753	783	813	843
244	424	454	484	514	544	574	604	634	664	694	724	754	784	814	844
245	425	455	485	515	545	575	605	635	665	695	725	755	785	815	845
246	426	456	486	516	546	576	606	636	666	696	726	756	786	816	846
247	427	457	487	517	547	577	607	637	667	697	727	757	787	817	847
248	428	458	488	518	548	578	608	638	668	698	728	758	788	818	848
249	429	459	489	519	549	579	609	639	669	699	729	759	789	819	849
250	430	460	490	520	550	580	610	640	670	700	730	760	790	820	850
401	431	461	491	521	551	581	611	641	671	701	731	761	791	821	851
402	432	462	492	522	552	582	612	642	672	702	732	762	792	822	852
403	433	463	493	523	553	583	613	643	673	703	733	763	793	823	853
404	434	464	494	524	554	584	614	644	674	704	734	764	794	824	854
405	435	465	495	525	555	585	615	645	675	705	735	765	795	825	855
406	436	466	496	526	556	586	616	646	676	706	736	766	796	826	856
407	437	467	497	527	557	587	617	647	677	707	737	767	797	827	857
408	438	468	498	528	558	588	618	648	678	708	738	768	798	828	858
409	439	469	499	529	559	589	619	649	679	709	739	769	799	829	859
410	440	470	500	530	560	590	620	650	680	710	740	770	800	830	860
411	441	471	501	531	561	591	621	651	681	711	741	771	801	831	861
412	442	472	502	532	562	592	622	652	682	712	742	772	802	832	862
413	443	473	503	533	563	593	623	653	683	713	743	773	803	833	863
414	444	474	504	534	564	594	624	654	684	714	744	774	804	834	864
415	445	475	505	535	565	595	625	655	685	715	745	775	805	835	865
416	446	476	506	536	566	596	626	656	686	716	746	776	806	836	866
417	447	477	507	537	567	597	627	657	687	717	747	777	807	837	867
418	448	478	508	538	568	598	628	658	688	718	748	778	808	838	868
419	449	479	509	539	569	599	629	659	689	719	749	779	809	839	869
420	450	480	510	540	570	600	630	660	690	720	750	780	810	840	870

SEND COPIES OF FOLLOWING ARTICLES IN THIS ISSUE
Page No. Title of Article

.....
.....
.....
.....
.....

CARD INVALID WITHOUT COMPANY NAME — TYPE OR PRINT

NAME

TITLE

COMPANY

PRODUCT MANUFACTURED

ADDRESS

CITY ZONE

STATE

Do not use this card after Aug. 23, 1960

MACHINE DESIGN **June 23, 1960**

Circle item number for information on products advertised or described or copies of literature.

241	421	451	481	511	541	571	601	631	661	691	721	751	781	811	841
242	422	452	482	512	542	572	602	632	662	692	722	752	782	812	842
243	423	453	483	513	543	573	603	633	663	693	723	753	783	813	843
244	424	454	484	514	544	574	604	634	664	694	724	754	784	814	844
245	425	455	485	515	545	575	605	635	665	695	725	755	785	815	845
246	426	456	486	516	546	576	606	636	666	696	726	756	786	816	846
247	427	457	487	517	547	577	607	637	667	697	727	757	787	817	847
248	428	458	488	518	548	578	608	638	668	698	728	758	788	818	848
249	429	459	489	519	549	579	609	639	669	699	729	759	789	819	849
250	430	460	490	520	550	580	610	640	670	700	730	760	790	820	850
401	431	461	491	521	551	581	611	641	671	701	731	761	791	821	851
402	432	462	492	522	552	582	612	642	672	702	732	762	792	822	852
403	433	463	493	523	553	583	613	643	673	703	733	763	793	823	853
404	434	464	494	524	554	584	614	644	674	704	734	764	794	824	854
405	435	465	495	525	555	585	615	645	675	705	735	765	795	825	855
406	436	466	496	526	556	586	616	646	676	706	736	766	796	826	856
407	437	467	497	527	557	587	617	647	677	707	737	767	797	827	857
408	438	468	498	528	558	588	618	648	678	708	738	768	798	828	858
409	439	469	499	529	559	589	619	649	679	709	739	769	799	829	859
410	440	470	500	530	560	590	620	650	680	710	740	770	800	830	860
411	441	471	501	531	561	591	621	651	681	711	741	771	801	831	861
412	442	472	502	532	562	592	622	652	682	712	742	772	802	832	862
413	443	473	503	533	563	593	623	653	683	713	743	773	803	833	863
414	444	474	504	534	564	594	624	654	684	714	744	774	804	834	864
415	445	475	505	535	565	595	625	655	685	715	745	775	805	835	865
416	446	476	506	536	566	596	626	656	686	716	746	776	806	836	866
417	447	477	507	537	567	597	627	657	687	717	747	777	807	837	867
418	448	478	508	538	568	598	628	658	688	718	748	778	808	838	868
419	449	479	509	539	569	599	629	659	689	719	749	779	809	839	869
420	450	480	510	540	570	600	630	660	690	720	750	780	810	840	870

SEND COPIES OF FOLLOWING ARTICLES IN THIS ISSUE
Page No. Title of Article

.....
.....
.....
.....
.....

CARD INVALID WITHOUT COMPANY NAME — TYPE OR PRINT

NAME

TITLE

COMPANY

PRODUCT MANUFACTURED

ADDRESS

CITY ZONE

STATE

Do not use this card after Aug. 23, 1960

MACHINE DESIGN **June 23, 1960**

Circle item number for information on products advertised or described or copies of literature.

241	421	451	481	511	541	571	601	631	661	691	721	751	781	811	841
242	422	452	482	512	542	572	602	632	662	692	722	752	782	812	842
243	423	453	483	513	543	573	603	633	663	693	723	753	783	813	843
244	424	454	484	514	544	574	604	634	664	694	724	754	784	814	844
245	425	455	485	515	545	575	605	635	665	695	725	755	785	815	845
246	426	456	486	516	546	576	606	636	666	696	726	756	786	816	846
247	427	457	487	517	547	577	607	637	667	697	727	757	787	817	847
248	428	458	488	518	548	578	608	638	668	698	728	758	788	818	848
249	429	459	489	519	549	579	609	639	669	699	729	759	789	819	849
250	430	460	490	520	550	580	610	640	670	700	730	760	790	820	850
401	431	461	491	521	551	581	611	641	671	701	731	761	791	821	851
402	432	462	492	522	552	582	612	642	672	702	732	762	792	822	852
403	433	463	493	523	553	583	613	643	673	703	733	763	793	823	853
404	434	464	494	524	554	584	614	644	674	704	734	764	794	824	854
405	435	465	495	525	555	585	615	645	675	705	735	765	795	825	855
406	436	466	496	526	556	586	616	646	676	706	736	766	796	826	856
407	437	467	497	527	557	587	617	647	677	707	737	767	797	827	857
408	438	468	498	528	558	588	618	648	678	708	738	768	798	828	858
409	439	469	499	529	559	589	619	649	679	709	739	769	799	829	859
410	440	470	500	530	560	590	620	650	680	710	740	770	800	830	860
411	441	471	501	531	561	591	621	651	681	711	741	771	801	831	861
412	442	472	502	532	562	592	622	652	682	712	742	772	802	832	862
413	443	473	503	533	563	593	623	653	683	713	743	773	803	833	863</

FIRST CLASS
Permit No. 36
CLEVELAND, OHIO

BUSINESS REPLY MAIL

No Postage Stamp Necessary if Mailed in the United States

—POSTAGE WILL BE PAID BY—

MACHINE DESIGN

Penton Building

Cleveland 13, Ohio

Reader's Service Dept.



FIRST CLASS
Permit No. 36
CLEVELAND, OHIO

BUSINESS REPLY MAIL

No Postage Stamp Necessary if Mailed in the United States

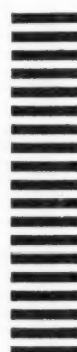
—POSTAGE WILL BE PAID BY—

MACHINE DESIGN

Penton Building

Cleveland 13, Ohio

Reader's Service Dept.



FIRST CLASS
Permit No. 36
CLEVELAND, OHIO

BUSINESS REPLY MAIL

No Postage Stamp Necessary if Mailed in the United States

—POSTAGE WILL BE PAID BY—

MACHINE DESIGN

Penton Building

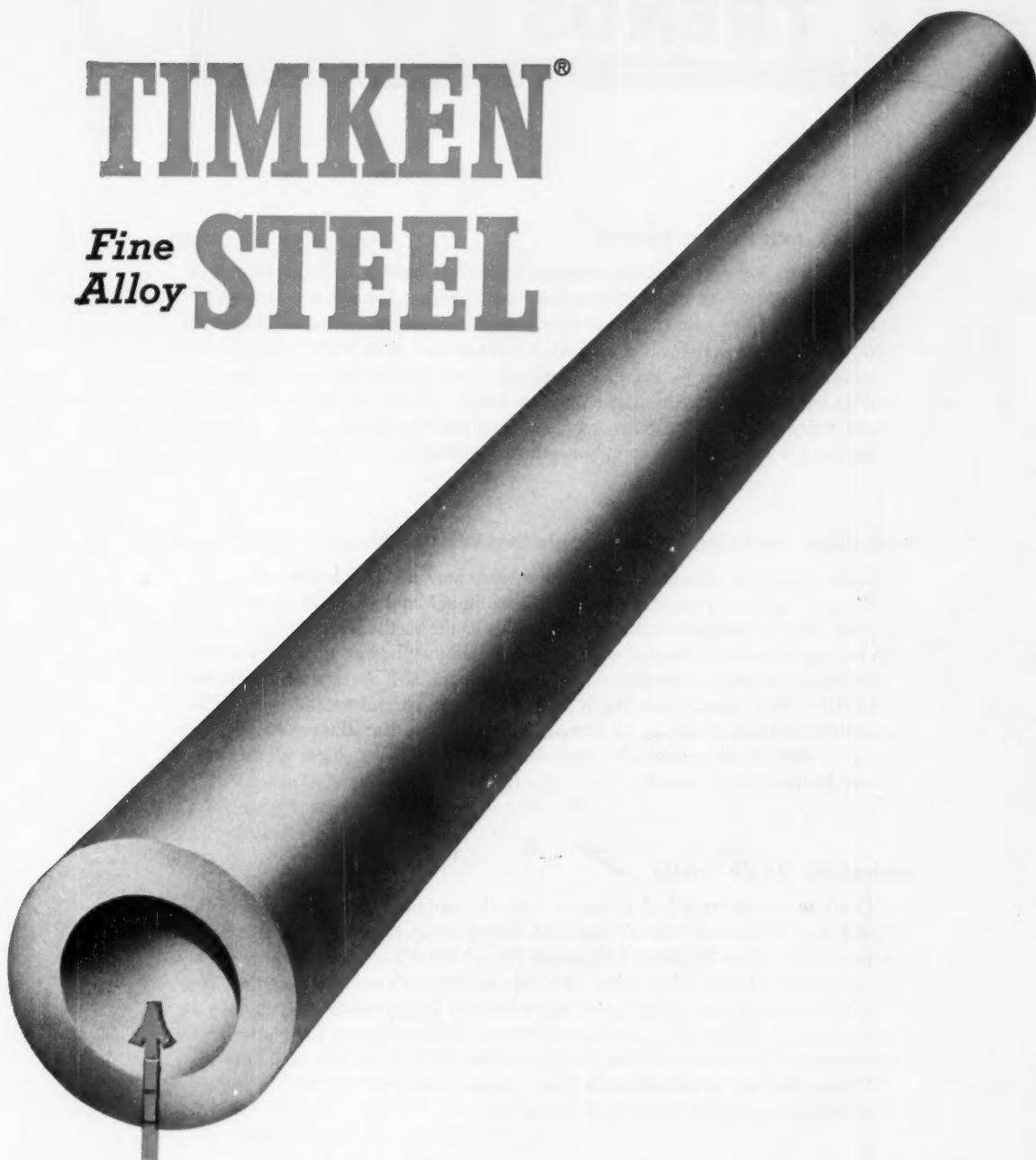
Cleveland 13, Ohio

Reader's Service Dept.



TIMKEN®

Fine Alloy **STEEL**



Ready-made savings for your hollow parts

Why bore out bar stock to make your hollow parts? Start with Timken® seamless steel tubing; the hole's already there. You save drilling costs, steel, machining time and you're sure of uniform quality finished parts, too. That's because we make Timken steel tubing by forging a solid round over a mandrel, thoroughly working the metal inside and out. This gives the tubing its fine forged quality and uniform spiral grain flow.

When you buy Timken steel you always get:

1) *Quality* that's uniform from heat to heat, tube to tube, order to order; 2) *Service* from the experts in specialty steels; 3) Over 40 years of *experience* in solving tough steel problems. Let our engineers help you save by recommending the most economical tube size for your hollow parts job . . . one guaranteed to clean up to your finish dimensions. The Timken Roller Bearing Company, Steel and Tube Division, Canton 6, Ohio. Cable address: "TIMROSCO". *Makers of Tapered Roller Bearings, Fine Alloy Steel and Removable Rock Bits.*

TIMKEN ALLOY STEEL AND SEAMLESS STEEL TUBING ARE AVAILABLE FROM STEEL SERVICE CENTERS IN 44 CITIES IN THE UNITED STATES

research mutes the mower

More sleep for suburbanites seems sure to result from a humane project recently completed at Armour Research Foundation. Acoustic specialists there have successfully quieted gasoline-powered lawnmowers. Production models of the quiet mowers will sound as if they are at least three times farther away, says William C. Perry, ARF physicist; additional silencing is also possible by sacrificing performance and economy. Changes designed into standard noisy lawnmowers include an S-shaped cutting blade, a circular domed engine cover (lined with sound-absorbent material), and a quiet muffler.

vanadium: middleman in titanium-steel sandwich

Steel, always in search of new applications, may soon find use around wet chlorine and other vicious oxidizers. Titanium Metal Corp. of America has found a way to weld titanium to steel. Key to the method is use of a "butter" of vanadium—titanium and steel are dissimilar metals, but vanadium is compatible with both. To form the combination, TMCA experimenters drill small holes in steel, then fusion weld vanadium plugs into the holes. Protective titanium facing is, in turn, fusion welded to the plugs with titanium rod. Vanadium's drawback—cost—isn't a major factor because the plugs can be made quite small.

ex-bosses don't tattle

Don't worry about a bad reference from the ex-boss. He may not give it—and even if he does, it won't keep you from getting that new job. This happy note comes from "Industrial Relations News," New York, which ran a survey on company personnel policies. A single negative reference doesn't hurt your chances—but if too many unfavorable reports finally come in, you may be discharged. Other findings: Sixty per cent of the surveyed companies check references before hiring; the others wait until the new man is in the fold. When checking, personnel men plead for an honest report, but the majority of companies admit they don't tattle.

government helps those who help themselves

Plans to supply small business with government technical know-how are getting up steam. A two-part program will be operated jointly by the Small Business Administration and the Office of Technical Services, Dept. of Commerce. The government aims to help small business help itself to the reams of research data made available by the Commerce Department. For the first part of the experimental information program, SBA plans to mail blanket notices of new reports of special interest to small business. Response will help determine future policy for the second part, the research-data program, in which information will be selectively distributed.

monorail monologue

Monorails are "fundamentally unsound, an exhausted art," and they're unlikely to provide economical rapid transit, William H. T. Holden, consulting engineer, told an ASME meeting recently. They have no advantages to commend their use, he continued, and managers of companies interested in manufacturing them are, as a rule, not informed on transit fundamentals. Interest in monorails is chiefly a reaction to the overweight, underpowered equipment now used on conventional commuter lines. Solution to transit problems, says Mr. Holden, is improvement of two-rail systems.

world-wide drawing standards in sight

As overseas subsidiaries multiply, differences in international engineering-drawing practices become more and more noticeable—and costly. While U.S. drawings are reasonably standardized, European countries are still plagued with a babel of symbols and callouts. They're now doing something about it. Recently, in Lisbon, Portugal, the International Organization for Standardization, with 23 countries represented, held its third plenary meeting. Main agenda item: How to reconcile differences in representation of tolerances. Mr. C. E. Hilton, of the U. S. Graphic Standards Board attended the meeting, but only as an observer—so far. The U. S., Britain, and Canada co-ordinated drawing practices in a conference in 1957.

plug-in maintenance

One of the biggest problems with U. S. equipment at home and abroad is maintenance, reports the industrial design firm of Lippincott and Margulies Inc., New York. As they see it, one solution would be to divide functional areas of each machine into "packages," a concept well established in electronic design. Each package could be a self-contained modular plug-in unit, complete with a signal light that would go on in case of malfunction. Maintenance would consist of checking lights, unplugging defective units, and inserting new ones. Repair time would be minimized and spare part inventories would be less of a headache.

educators look at nuclear engineering

Studies slated to begin in September should help nuclear-engineering hopefuls pick a school. Thirty experts in nuclear engineering, financed by AEC and sponsored by the American Society of Engineering Education and the American Nuclear Society, will visit colleges to determine underlying philosophies and objectives of the various curriculums. After gathering this information, they will set up guide posts for future use by the universities. The work is necessary because the field is so new: Different schools offer wide variations in both level and content of courses.

if you use TORQUE MOTORS

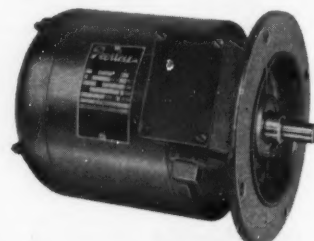
... the name is *Peerless*

The torque motor, unlike any other electric motor, is a special from the word go. That situation alone makes Peerless one of the best sources for torque motors in ratings from 2 oz. in. to 200 lb. ft.

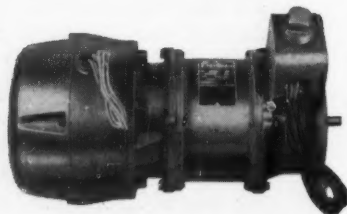
Torque motors deliver maximum rated torque without damage to the windings when stalled across the line at full voltage for predetermined periods. Peerless also builds torque motors which provide a nearly constant torque while operating at less than synchronous speeds.

All standard frame sizes; all types of mountings; high torques; special paint and varnish treatments;

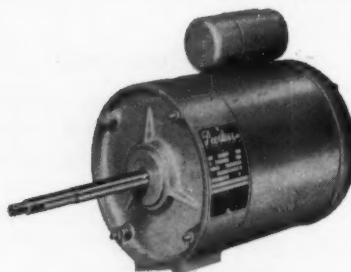
and Class A, B and H insulation are available from Peerless. Torque motors require unusually close cooperation between the motor supplier and the customer's engineers. This cooperation is a Peerless specialty. We will work with you to produce the one torque motor that powers your product best.



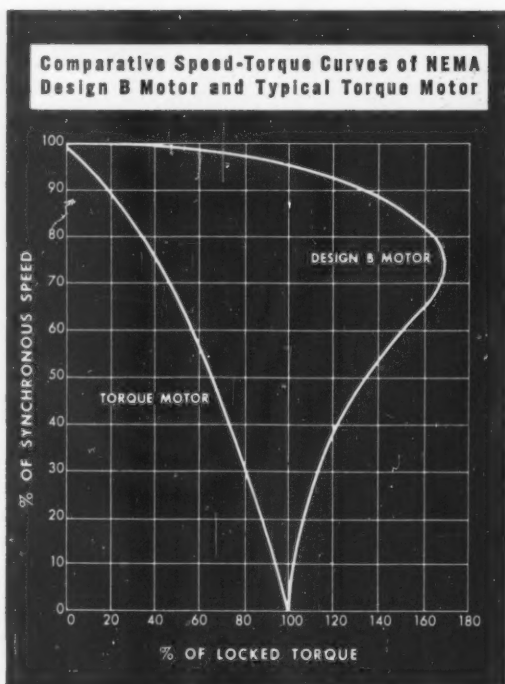
Weather-Tight Special Flange



Explosion-Proof Torque Motor with Brake



Special Flange Reversing Hoist Motor Single Phase



The speed-torque curve varies from that of a conventional motor. The torque motor curve is almost linear. Maximum torque occurs at the stalled position. For this reason, torque motors are used most often where a holding or resisting force is required.

NEW TORQUE BULLETIN-This bulletin outlines basic facts about Peerless torque motors and shows applications. It is available **FREE**. Write for it today.



Peerless Electric Division, H. K. Porter Company, Inc., Warren, Ohio

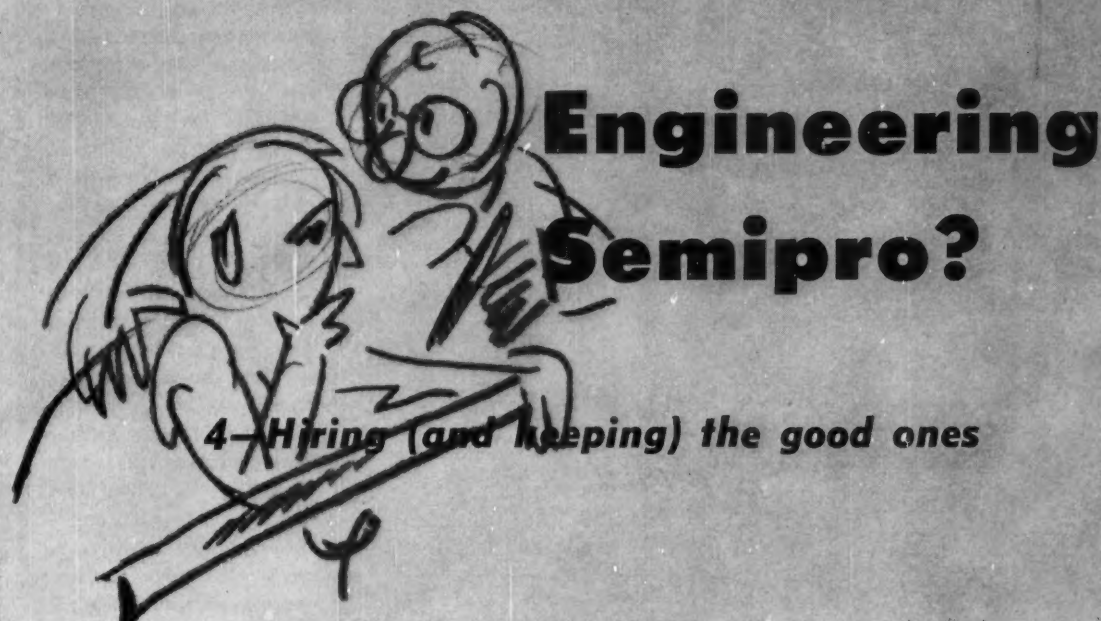
PEERLESS ELECTRIC DIVISION

PORTER

H. K. PORTER COMPANY, INC.

PORTER SERVES INDUSTRY with steel, rubber and friction products, asbestos textiles, high voltage electrical equipment, electrical wire and cable, wiring systems, motors, fans, blowers, specialty alloys, paints, refractories, tools, forgings and pipe fittings, roll formings and stampings, wire rope and strand.

Close-up of the technician:



Engineering Semipro?

4-Hiring (and keeping) the good ones

TURNOVER for technicians is terrific. In fact, many companies claim the rate is double that for engineers, and some say it reaches 25 per cent each year. Discontent and unrest are always costly, but losing one quarter of the technician workforce annually can be disastrous. Best reason turned up is that technicians seem to feel either the job or the future was misrepresented during initial employment interviews.

Old hiring practices are being overhauled, but progress is slow—personnel policies don't change overnight. In recent years, however, management has learned much on how to hire and keep the good technician.

Getting Him to the Door

The search for technicians today requires almost as much effort as the engineer hunt. Employment agencies, newspaper and magazine ads, and employee referrals are helping to fill the gap, but recruiting trips to schools are also important. The day is past when technicians walk in off the street and

ask for jobs. New hiring techniques are aimed at applicants who understand and will be content with the work situation as it exists—and with the few special inducements recruiters can offer.

Advertisements bring in lots of "general technicians" but they don't reach special types, employers generally agree. Detailed recruiting programs have proved more profitable. Junior colleges and technical institutes—and even some vocational trade schools—are turning out technicians with a wide variety of backgrounds; modern managers are getting familiar with these schools. By comparing educational curriculums, they are able to determine sources of technician manpower that seem well matched to the requirements of the job.

Many companies regularly prepare and send out (to technical institutes) literature describing job opportunities. Most of this is general, covering engineering opportunities at all levels, but some is aimed specifically at technicians. Hiring is getting competitive and managers are taking advantage of

every opportunity to pre-sell.

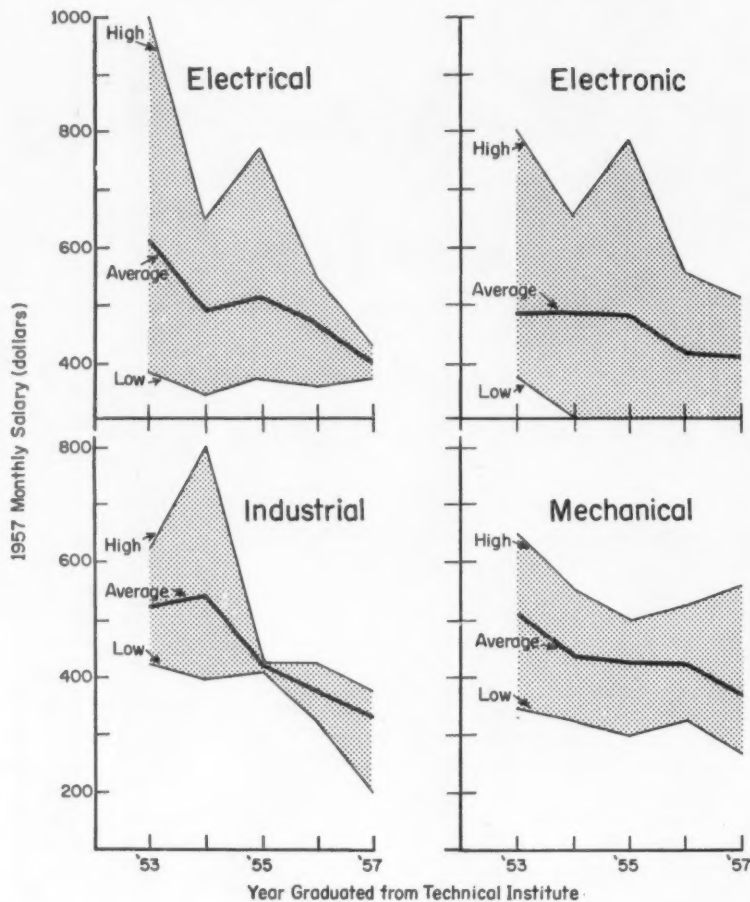
Recruiters visit technical institutes almost as often as engineering schools, and they put prospective technicians through the same kind of screening as beginning engineers. Psychological tests, personal biographies, and vocational tests all play a part.

Minimum standards for knowledge and abilities of a technician, recommended by the National Committee for the Development of Scientists and Engineers, help in the screening process:

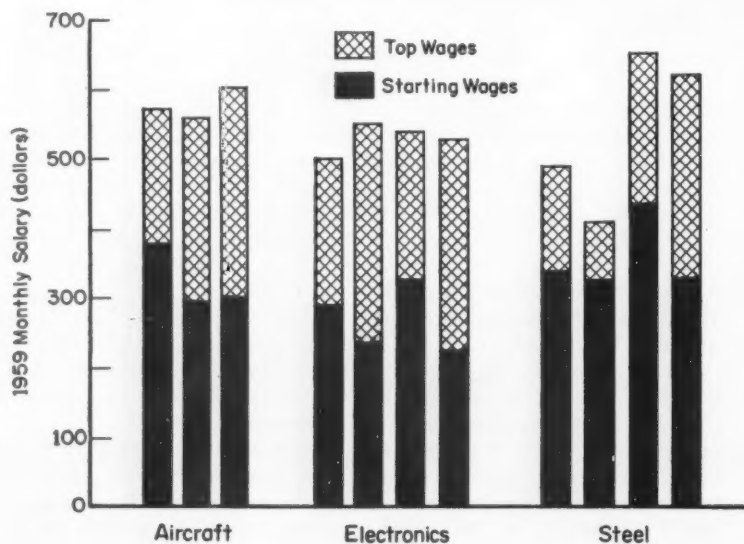
- He should have sufficient scientific and engineering knowledge to independently carry through a simple analysis in at least one special field.
- He should know how to apply college algebra, analytical geometry, trigonometry, and logarithms.
- He should be able to plan and draw diagrams.
- He should be capable of applying new ideas to technical problems.

Once the technician has been approved by the recruiter, a visit to the company is next. This phase is critical. The company, now really

How Much Pay?



Salary questionnaires sent out by Southern Technical Institute in 1957 to 1250 recent graduates came back to tell a happy story: Technicians graduating from STI seem to be extremely well paid. Evidently, if these graduates are typical, many technicians earn as much money as engineers, at least in early stages of their careers. For analysis, the 459 questionnaires returned were broken down into two categories: 1. Years since graduation. 2. Industry employing the technicians. Not enough returns were received for the survey to be statistically valid (in some groups—graduates of a particular year working in a given industry—less than ten replies were received). But the survey did point out that some technicians do command excellent salaries.



On the other hand, replies to questionnaires sent in 1959 to managers in aircraft, electronics, and steel companies told a different story: Data from three aircraft, four electronic, and four steel companies (left) show pay scales are rather tightly controlled. While wages vary within an industry, only a few technicians come close to engineering pay. However, most do not have technical-institute educations, and, possibly, those who are earning larger salaries may no longer be classified as technicians.

interested in the applicant, often finds it necessary to sell him on accepting an offer.

During the visit, the technician meets supervisory personnel who will have contact with him. Managers emphasize the importance of approval by the "first-line" supervisors. They stress that these people will have the responsibility for training him, and should have part of the final hiring decision.

Special Inducements

Competition for qualified technical support personnel requires that management understand what technicians expect to find on their jobs. Reports indicate several fringe benefits sway them and, more important, keep them on the job once they've started.


► **Educational programs:** Technicians want to break into the engineering field. Recognizing this desire, many firms have set up programs that push the technician's educational level upwards. Such programs increase the skill and quality of employees and tend to serve as incentive in the day-by-day performance of duties. Some companies even claim programs of this type can produce engineers from within the organization.

► **Paid tuition:** As an alternate to on-the-job training, paid-tuition plans stress self-development. The amount of educational assistance granted varies over a wide range from one company to another. Some pick up the whole tab and even grant time off to attend classes. Others pay only part of the tuition—and only for courses that directly apply to the employee's job. Paid-tuition programs seem to appeal more to the technician than to any other member of the technological team.

► **Method of compensation:** Recommended practice (in an earlier article of this series) is to pay technicians on a salary basis. Many companies also recommend treating them as nonexempt employees and paying them time-and-a-half for overtime. By building prestige for technicians in this way, managers are able to make them feel more closely associated with the profes-

Chemically Inert Dry Bearing Material

Chemloy 719*



use without lubricant!

Chemloy 719 is proving to be the most *universal* dry bearing material ever offered to industry:

... because its extremely low coefficient of friction invites use where lubrication is impossible, impractical or undesirable.

... because it may be used on both sliding and rotating applications over a wide temperature range.

... because it is impervious to practically all known chemicals, solvents or corrosives.

... because it is excellent under vibration or shock service conditions.

... because it will not conduct electricity or cause galvanic corrosion.

Chemloy 719 is available in all basic forms—such as sheet, rod or tubing—or in parts molded or machined to specifications. Get full details.

*The best in Teflon based bearing materials.

Request Bulletin T-120 and Price Sheet No. 126, or send b/p specs. for quotation on *molded* or machined parts. Crane Packing Company, 6425 Oakton St., Morton Grove, Ill. (Chicago Suburb). In Canada: Crane Packing Co., Ltd., Hamilton, Ontario.



Teflon is a DuPont Trademark



CRANE PACKING COMPANY

Women Technicians:

A Neglected Resource?

Women have not found their way onto scientific teams in any great numbers. Census data show they make up one third of the total workforce; however, only 7 per cent of draftsmen, 22 per cent of testing technicians, and 14 per cent of all technicians (outside the health fields) are women. Companies cite the following reasons:

- They can't be used where isolation, shift rotation, and manual labor are necessary.
- Integrating them into the all-male shop is difficult.
- Unions demand that men's work be performed by men.
- Jobs are too strenuous and dirty.
- They won't travel.
- Turnover is too high.

The arguments are strong, but not as strong as they might seem. In government work, civil service regulations provide easier paths to technical jobs, and women have earned wide acceptance. One large laboratory points out that the ladies make up more than 40 per cent of the workforce and that their work has been excellent. Bell Telephone Co. points with pride to the accomplishments of several female members of its technical staff. Other sources report women are especially suited for lab work, drafting, quality control, and technical writing.



Photo, courtesy Boeing Airplane Co.

sionals (engineers), and differentiated from production workers. This procedure develops a "career" rather than "just a job" attitude.

► **Working conditions:** Although generally satisfactory, working conditions also influence the technician's career vs. just-a-job thinking. Noisy surroundings are inevitable on jobs associated with production and manual labor, but the "engineering aide" needs peace and quiet—perhaps a desk of his own in a quiet area where he can do his thinking and mathematical computations. In any case, managers should make clear to prospective technicians what the work situation will be.

On-the-Job Training

Because additional schooling, in one form or another, greatly interests technicians and adds to their worth, managers should take a good look at ways of providing such

schooling. Industry has found that large numbers of technicians can be developed successfully through company training programs.

Since only about half of the top quarter of high school graduates enter college, there exists a large pool of trainees with sufficient intelligence to grasp scientific and mathematical principles. Many of these have gained considerable knowledge prior to joining a company—graduates of armed service schools and technical high schools, in particular.

Training programs take several forms. Almost all companies improve the background and abilities of technicians by informal training. Instruction, provided by scientists, engineers, and/or senior technicians, is necessary for a technician facing an unfamiliar job for the first time. In addition, semi-informal training is sometimes arranged for newly hired technicians.

Some companies direct on-the-job training toward specialized ends, but others have a broader objective: Attainment of general understanding of technicians' work throughout the company. Assigning technicians to a number of jobs during the initial training period is a common procedure.

Many large corporations combine on-the-job training with formal company classroom studies. Instruction is generally offered free to personnel on a part company time, part free time basis. Other managers recommend formal training for a period of weeks to fulfill a specific objective, rather than a continuous formal-training program.

Tools Should Be Provided

Usually, technicians are supplied with all the equipment they will need. In very few companies does he have to provide any personal equipment—such as his own small tools (screwdrivers, drawing instruments, etc.), slide rule, or safety shoes. Even in these cases, the company usually makes equipment available to the technician at a very nominal cost.

Telephones are generally available for technicians' use, but private phones are rare. Calculators are shared by technicians who do a lot of computing.

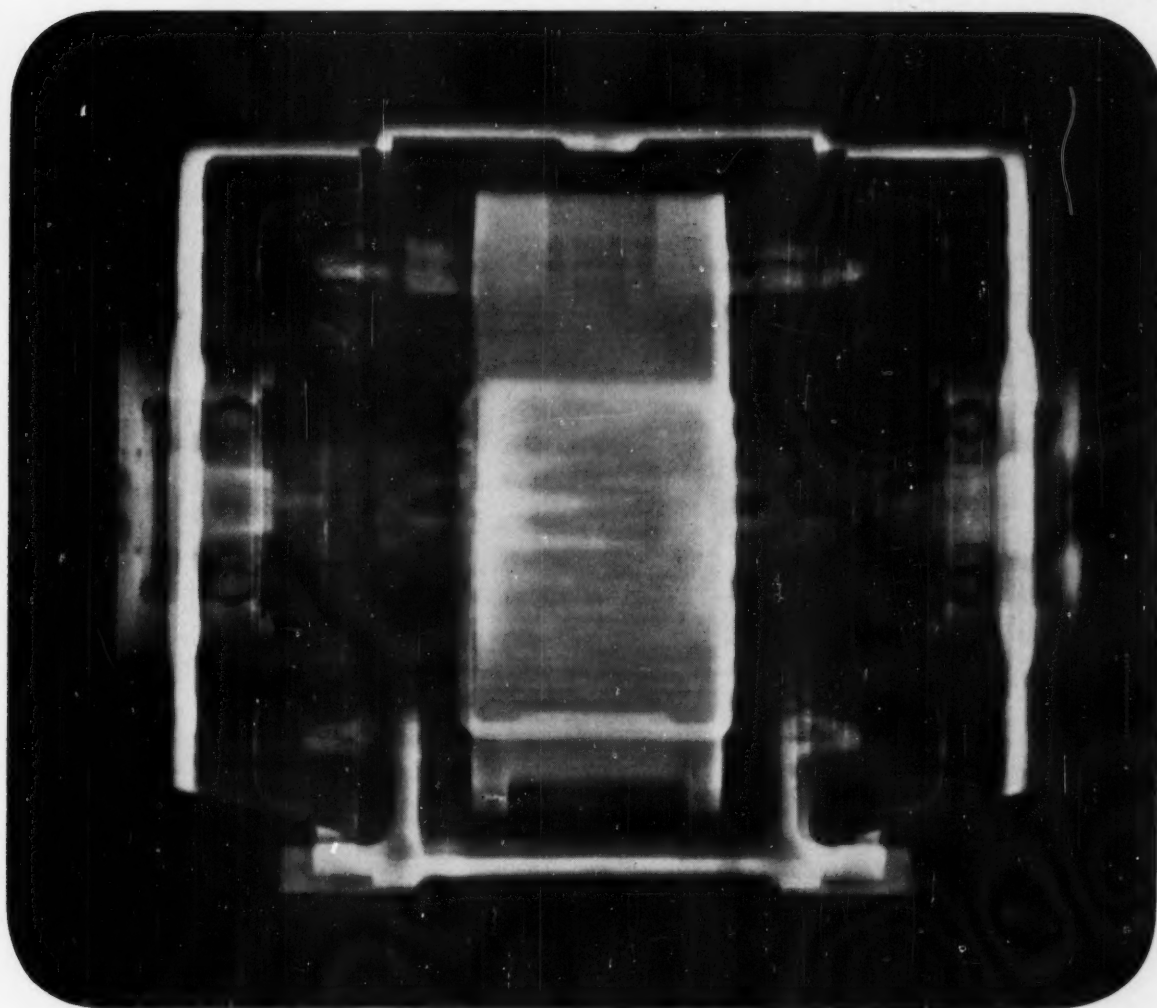
Nearly every company that maintains a technical library opens it to technicians. Of course, libraries are sometimes at one central location, and technicians working elsewhere do not find them easily accessible.

This article concludes the series. Earlier articles appearing in the May 12, May 26, and June 9, 1960, issues of MACHINE DESIGN, discussed: Who are technicians? What do they think of their future? What do managers think of them? The complete report, *Managing Technician Manpower*, on which the article series is based, may be purchased from Technician Manpower Associates, P. O. Box 158, Scarsdale, N. Y. for \$18.50 per copy.

ALLIS-CHALMERS



A-1337



Actual radiograph of a 5-hp open-type motor taken with a 24-million volt Allis-Chalmers Betatron.

X-ray view of motor health

Invisible standards of perfection increase life expectancy of every Allis-Chalmers motor

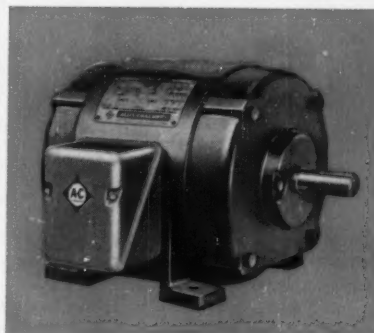
The exceptionally long performance of A-C open motors proves the value of thinking *beyond* established standards of design . . . of taking "significant new achievement" as the ideal.

This ideal led to many refinements for A-C open motors: double-shielded bearings that keep dirt out and allow controlled migration of grease, permanently numbered lead spacer and leads for easy identification and connection, and heavy-duty cast iron frames that resist corro-

sion and keep rotating parts perfectly aligned.

For totally-enclosed, open-type and *Super-Seal* general purpose motors, and electrically or mechanically modified definite-purpose motors, choose the motor built to invisible standards of perfection. Choose A-C. Special application help available.

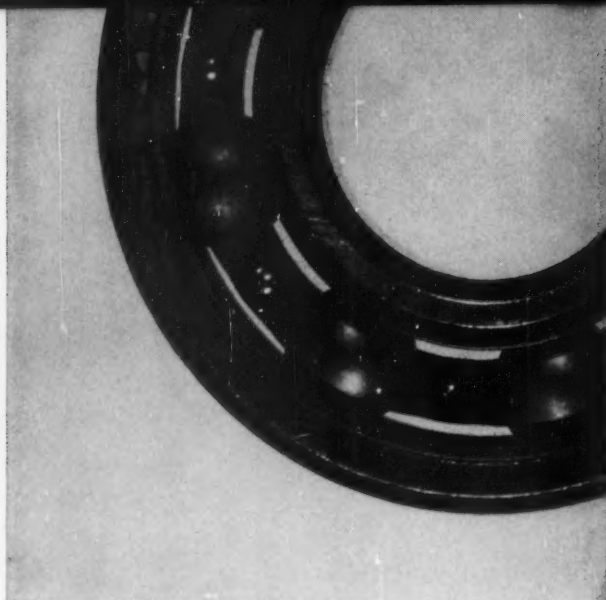
Call your nearby A-C representative. Or write **Allis-Chalmers, Industrial Equipment Division, Milwaukee 1, Wis.** *Super-Seal* is an Allis-Chalmers trademark.



Navy's Aero Materials Lab is

Toughening the Dry-Film Lubes

*Ball bearings coated with
new inorganic films beat
subzero chill, 800-F heat*



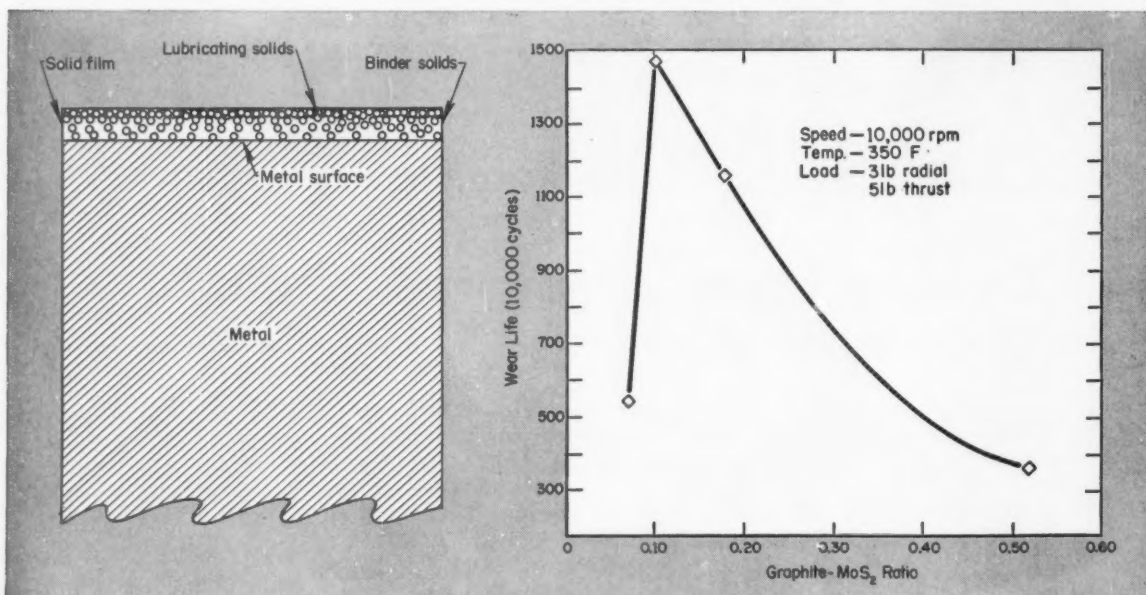
FOR SHEER TORTURE of ball bearings, few earth-bound devices can hold a candle to high-performance aircraft and missiles. Environmental rigors already run the gamut, and they'll get worse when nuclear-powered spacecraft become operational. Conventional lubricants can be wrecked in minutes by temperatures that range from near absolute zero to beyond 800 F, high-level nu-

clear radiation, and pressures in the micron range.

Even solid-film lubricants—now well-established in plain-bearing service—have shown serious limitations when they've been tried in hot, high-speed ball bearings. The trouble, say lubricant specialists at Naval Air Material Center, Philadelphia, is in the organic resins that have been used as binders for

lubricating solids like graphite and molybdenum disulphide. Generally such resins are unstable; they separate from base metals at high temperatures.

A research project under way at the Aeronautical Materials Laboratory has turned up a promising solution: Inorganic binders (sodium silicate seems to be best) are being substituted for the heat-sensitive



Typical gradient of lubricating solids in a continuous binder medium is shown in exaggerated cross section, left. Aeronautical Materials Lab studies have proved that a molybdenum disulphide and graphite mixture (sodium-silicate binder) is most satisfactory for high-speed lightly loaded

ball bearings. Races and balls in test bearings were chrome-alloy steel (AISI-C52100); retainers were carbon steel (AISI-C1010). Wear life vs. graphite-MoS₂ weight ratio (sodium-silicate binder) is plotted at right. Optimum size for the molybdenum-disulphide powder was about 6 microns.



Nothing puts the chill faster on a dry-film-lubricated ball bearing than running it immersed in liquid oxygen. Aeronautical Materials Lab specialists pumped LOX from a flask (left) into a stainless-steel beaker containing a bearing coated with an experimental inorganic dry film. At a temperature of -296 F, the bearing was run for 1 hr at 3600 rpm under a 5-lb thrust load. A 21-hr run at 10,000 rpm and 350 F followed—proving the durability of the inorganic binder.

resins. To prove out the concept, test ball bearings were coated with inorganic solid-film (MoS_2 , graphite, and sodium silicate) lubricants. They checked out as follows:

- Satisfactory performance when immersed in liquid oxygen.
- No reaction in the LOX detonation test.
- No damaging effects by high-level gamma-ray dosage ($5 \times 10^9 \text{r}$).
- Lubrication for periods up to 240 hr.
- Good stability in air at temperatures to 800 F.
- No damage under pressures less than 1 micron at 1000 F.

While looking for immediate answers, Materials Lab researchers M. J. Devine, E. R. Lamson, and J. H. Bowen are also building a lubricant technology that will guide future investigations. They've found that a major factor establishing wear life for solid-film-lubricated bearings is the substrate treatment. While pretreatment has in the past been considered essential for good bonding of the film to the base metal, a more important effect now seems to be the formation of "microreservoirs" which continuously augment the lube supply. Tests indicate that size, shape, number, and location of such reservoirs exert a strong influence on bearing life. Following up this concept, investigators modified retainers of a 204 ball bearing. Creation of the lubri-

cant reservoirs gave these remarkable bearing-test results:

Temperature (F)	Speed (rpm)	Life (hr)
350	10,000	113
350	1250	700
750	3500	96

An identical solid-film composition applied to an unmodified bearing (without pretreatment microreservoirs) gave results which proved the worth of the process:

Temperature (F)	Speed (rpm)	Life (hr)
350	10,000	29
350	1250	240

Another approach to solid-film lubrication, now under study at the laboratory, is based on the use of successively applied dry-film layers, each with a different chemical make-up. Layers are selected on the basis of characteristics desired in a particular temperature range.

An initial run with the multilayer film checked ball-bearing performance at 10,000 rpm and 350 F. Applied to an unmodified retainer, the two-component film comprised a base layer of AgI, graphite, and sodium silicate; top layer was MoS_2 , graphite, and sodium silicate. Bearing life obtained was 37 hr—comparing favorably with a 10-hr wear

life for the base layer alone and 29 hr for the top layer. Equivalent film thicknesses were used for all runs.

Also under study are the effects of MoS_2 particle size on ball-bearing performance. Wear life tests (10,000 rpm, 350 F) show that an average particle size of 6 microns gives the best results.

Following up on the laboratory phase of the investigation, Materials Lab personnel checked out performance of actual "hardware" in the field. Some of the results:

- Oscillating ball bearing; 650 F—Performance was satisfactory for more than 150 hr.
- Ball-screw jack; -65 to 840 F—Performance satisfactory, 482 hr.
- Thrust bearing; 840 F, 50 hr required—Satisfactory for desired life.
- Plain bearing; 750 F, 2400 rpm, light load—Satisfactory.
- Titanium alloy; prevent galling, provide wear resistance—Satisfactory.

There seems little doubt that pioneer research at the Center, supported by the Bureau of Naval Weapons, will eliminate excess weight in spacecraft lubricant systems, increase reliability of operation, and extend mission capabilities. Industry will also benefit.

MACHINE DESIGN's news report on dry-film lubricants is based on a summary prepared by H. Czatlicki, editor of the Air Material Center newspaper.

Stampings Without Stamping Are Low-Cost, Burr-Free

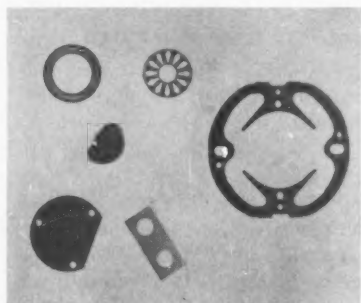
MINNEAPOLIS — Economical production of thin sheet-metal "stampings" by photographic reproduction can save up to 95 per cent of conventional tooling costs. This is the claim of Dayton Rogers Mfg. Co. for its new Photo-Mechanical Duplicating process, which offers the added advantages of freedom from burrs, precise dimensional control, complete flatness, and no distortion.

First step in the process is preparation of a black-and-white drawing of the part, accurately scaled to ten times original size. The drawing is photographed to reduce it to its original size, and a multiple negative is made which will cover the size sheet of metal to be used.

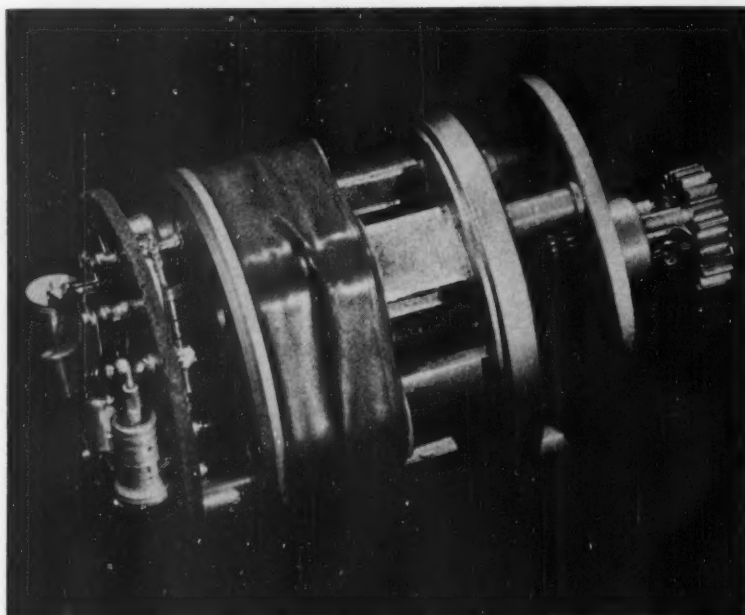
This photographic "die" is used with light-sensitive coating to make contact prints on the metal sheet. The image is developed, and bare metal areas are etched away to leave the parts. Final production step is removal of resist by rinsing. Parts are inspected to check tolerance.

Photo-Mechanical Duplicating can be used with material up to 0.020 in. thick. There is no minimum thickness, nor is there a limit on hardness of material, detail of part contour, or detail of part hole contour. Minimum cutout, protrusion, or hole size is equal to material thickness. Tolerances can be held to ± 0.002 in. in 6 in. on blank contour, hole location, and hole diameter.

Parts from 1/16 in. to 20 in. square can be made from sheet steel, stainless, brass, copper, bronze, beryllium, or any other metal or alloy that can be etched.

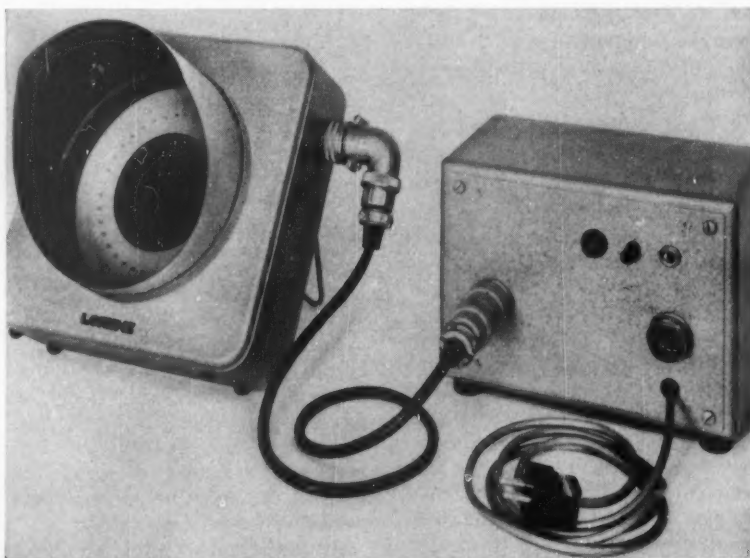


Paper-thin sheet metal parts made by photographic reproduction can be highly detailed. Secondary operations, such as drawing or forming, are possible.



DC Motor with an AC Character

Locked-rotor current of a tiny dc motor is no higher than its full-load current. Input is fed into a transistor control which produces a pulsed power supply whose frequency goes up with rotor speed. The motor, by Cook Electric Co., Chicago, has no commutator and is entirely spark-free in operation. Made in one size only—3 in. long, 1 3/4 in. diameter—the motor takes a current of 120 ma at 30 v, provides a torque of 8 lb-in. at 1 rpm. Basic speed of the unit is 1200 rpm.



Signal Decoder Beams Out Measured Angles

Angle data, transmitted in digital signal form, are automatically decoded and visually indicated by a new German instrument. Developed by Standard Elektrik Lorenz AG, Pforzheim, the device beams a light along a graduated scale, then cuts off all but a thin sliver. Small slots, strategically etched in a series of movable discs, determine which portion of the beam will be projected. Input signal, fed into electromagnetic actuators, revolves discs to "on" or "off" positions. Slots line up to allow only one light sliver to survive for each angle.



Bruning Neoglide Drafters. Speed drafting up to 35%! Unique design gives complete maneuverability on any board *at any angle* without adjustment. Counterweight provides "floating" action. Touch-control protractor speeds angle selection.



Bruning Electric Eraser. Minutes add up to hours saved over manual erasing. Bruning's original hollow-shaft eraser features 7" erasers for extra economy and tracing protection, provides convenient, finger-tip switch. Trouble-free sealed bearings.



Bruning Drafting Aids. They add up to hundreds of man-hours saved! Complete line includes everything from adjustable triangle for faster, accurate drawing of angles to special purpose templates for quicker, neater execution of symbols and shapes.



Bruning Drawing Materials. You save because Bruning gives you the exactly right paper, cloth, film or dimensionally stable medium for the job. You keep saving because Bruning materials provide faster, easier drawing, sharper reproduction.

Big Savings Are Sometimes a Lot of Little Savings!

In drafting, little things can add up to bigger and better things, fast! And no one knows it better than your Bruning Man.

That's why he is as eager to help you with such items as electric erasers, drafting machines, and drafting materials as he is with higher-priced Copyflex reproduction machines. He knows that the minutes and hours saved per drawing with these items multiply into big savings of hundreds of man hours each year. Even more, the right tools and equipment help draftsmen do better work, keep them happy and efficient in their jobs.

You'll find, too, that the day-by-day convenience and savings of using your Bruning Man as the single, dependable source for all you need in drafting pays off in big annual dividends! Why not take a little time now to mail the coupon; it can mean a lot to you, later.

BRUNING

Charles Bruning Company, Inc. Dept. 6-W
1800 Central Road, Mt. Prospect, Illinois

Offices in Principal U.S. Cities

In Canada: 103 Church St., Toronto 1, Ontario

Please send me information on

☐ Neoglide Drafters

☐ Bruning Electric Erasers

☐ Bruning Drafting Aids

☐ Bruning Materials

Name _____ Title _____

Company _____

Address _____

City _____ County _____ State _____

Circle 417 on Page 19

Designers Need To Bone Up On Plastics Possibilities

MIAMI, FLA. — Almost everything, from abacuses to zippers, is being designed with plastics in mind. But the plastics industry must not become complacent, Leland K. Warrick, Hotpoint Co., warned the Society of the Plastics Industry.

Complaints from some of the country's appliance manufacturers show that the new materials are far from perfect, and that designers aren't being taught to use them properly. It is the job of SPI to aid and counsel industry, to see that plastic parts are properly designed. And, says Warrick, society members should be urged to adopt the following "modus operandi":

- Work with quality-control people to establish realistic performance tests.
- Constructively criticize designers in their use of plastics.
- Keep industry informed of both advantages and limitations of new plastics.
- Refuse to make parts that will give unsatisfactory service.

Suitable education of designers-in-plastics, continues Warrick, would

eliminate most complaints, which fall into two categories: A misapplication of the material itself, or a lack of quality control in the manufacture of the part. Some reasons for trouble:

- Plastics age quickly (they're good for only five to ten years). Appliances, on the other hand, last ten years or longer.
- Parts assembled with self-tapping screws can be changed only two or three times before the threads strip.
- Plastic parts warp and flow in storage, making tolerances hard to hold.
- Little effort is made to protect plastic surfaces; even the vehicles used in household polishes are hard on them.

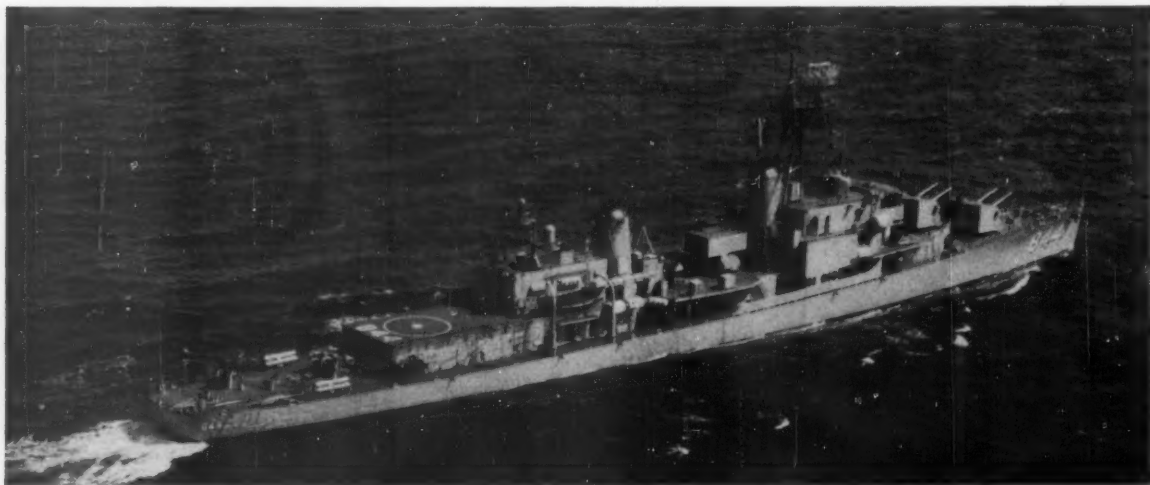
Although things can be done with plastics that could not be done with anything else, encouraging borderline applications just to sell poundage is a dangerous practice. It may result, in the long run, in lower sales and in less use of the material. Mr. Warrick cited the case of a custom molder using substitute material, which, though suitable structurally, gave the product an offensive smell. It goes without saying that the maximum acceptance of plastics will be achieved when plastic parts perform.



Semicured Insulator Tape Can Be Machine-Wound

Eliminating the "dip and bake" process of curing that sometimes must be repeated three times, a glass-cloth tape that can be economically machine-wound has been designed for Class B motor armatures or field windings. The semicured tape requires no interliner, can be directly applied to coils and cured without pressure. General Electric Co., Schenectady, N. Y., claims a single baking of 30 minutes to an hour at normal oven temperatures is all that is required. Additional uses for the tape include manufacture of laminates and molded forms such as coil spools, terminal boards, and relay covers.

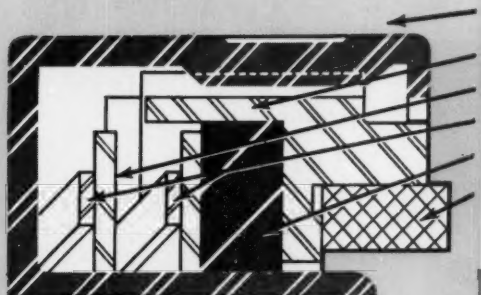
Signed-on for Eight More



Improvements in antisubmarine warfare capability and in crew comfort will be made in 124 Navy destroyers to lengthen their lives by 8 years. As part of the conversion, they will be equipped with two drone helicopters capable of firing homing torpedoes and eight long-range rocket torpedoes. The rocket torpedoes—ASROC—are the Navy's best in ASW.

They are missiles which fly to the target zone, carrying homing torpedoes or depth charges equipped with conventional or nuclear warheads. To make way for the new equipment, the destroyers' entire superstructures have been redesigned and rebuilt in aluminum, and all stern guns, old-fashioned torpedo tubes, and depth-charge stations have been removed.

GITS HH-TYPE SEAL SERIES



SHELL
ADAPTER
SEPARATOR
SPRING
FLAT PACKING RING
SEAL RING

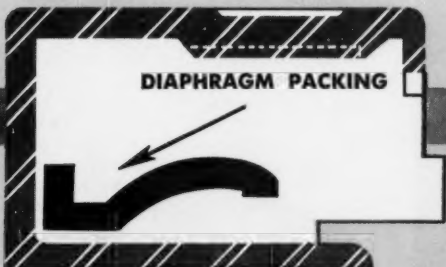
GITS



"O" RING PACKING



"V" PACKING RING



DIAPHRAGM PACKING



WEDGE PACKING RING

VITON "A"

All packings illustrated are available with new Viton "A" rubber compound, for highest temperature resistance and maximum resistance to aircraft and hydraulic fuels and lubricants.

Circle 418 on Page 19

*Extra Flexibility For
Your Seal Applications!*

ONE SEAL ENVELOPE WITH CHOICE OF FIVE SEAL PACKINGS

Use of this one standard Gits HH-type seal envelope — with your choice of the five seal packing arrangements illustrated at left — permits effective sealing (in the same seal cavity) over the widest possible range of operating conditions. And all these Gits Shaft Seals meet standard minimum space requirements.

Standard metal parts are stainless steel, except when the Gits Engineering Department recommends other materials to suit specific applications.

The sealing and packing members are engineered of proper materials to suit the operating conditions of each individual application.

Gits maintains the most complete facilities for design, engineering, research, development and testing, as well as the most modern manufacturing equipment. The Gits Engineering Department, with almost half a century of experience, has the know-how to blend proper materials with outstanding design, to make seals work better for you. Send for full information.

GITS BROS. MFG. CO.

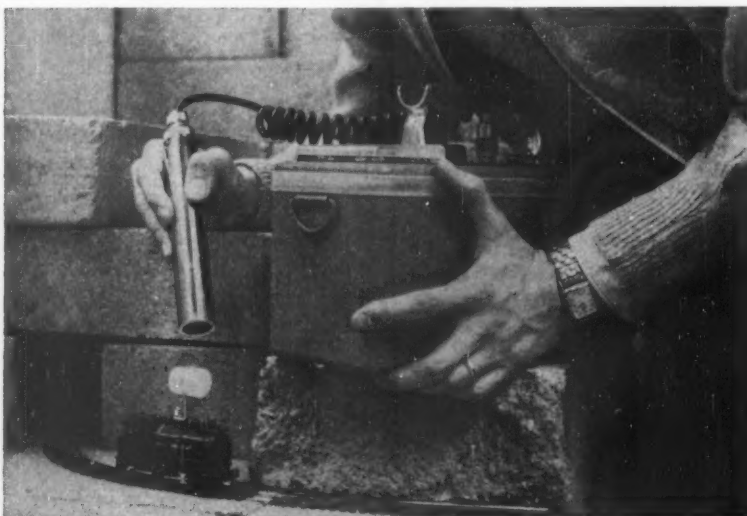
1868A South Kilbourn Avenue • Chicago 23, Illinois

NEW! Gits engineering advancement practically eliminates hysteresis or drag. Write for full details.



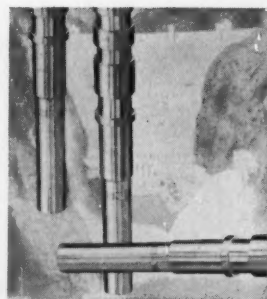
Ultrasonic Machine Tool Handles Small (or Big) Jobs

Ultrasonic machining on a small scale is made practical by a compact, low-cost Sheffield Corp. machine tool which also has the capacity for high production. For light output, the transducer and workpiece are mounted horizontally, as shown, in less than 9 by 36 in. of space. Tools up to 2 in. in diam can be used. For greater production, the transducer is mounted vertically, and an adapter attached to it transmits vibrations to as many as eight individual tools. These eight stations can be operated simultaneously or independently. A 1000-w electronic generator powers the standard model; if only one machining station is to be used, a 200-w generator is adequate.



World's Shortest and Hottest Railroad

Traveling along four feet of track, a toy locomotive runs samples of nickel isotopes in and out of a nuclear reactor at the University of Michigan. The track winds through a "tunnel" in the concrete block shielding, stops at the focal point of a neutron beam. Here, isotope samples mounted on the locomotive absorb bombarding neutrons and give off gamma rays. Samples differ in the number of neutrons present in their nuclei, and UM researchers are measuring gamma-ray intensities to chart energy levels of nuclei in each sample. The beam, fatal to man, makes the engine only slightly radioactive.



HOOVER DAM

call **WESTERN UNION** operator **25**

Your J&L stainless steel distributor can serve you better *because J&L serves him better*, backing him with the full facilities of J&L's Stainless and Strip Division.

Your J&L distributor can reduce your costs by providing a complete range of pre-production services, and doing it economically! He can save you the capital investment required to maintain long term inventories; he can help you eliminate the costs of overhead connected with stocking, accounting, and the inevitable losses incurred through waste and obsolescence due to specification changes.

Technical assistance in solving production problems is also available from your J&L distributor... when those problems are connected with an application using stainless steel, J&L's own staff of technical specialists will promptly answer your distributor's call for additional help.

Even when advanced research is required you can call on your J&L distributor in confidence. He will be happy to discuss your problem because he knows he is backed by one of the world's most respected teams of metallurgists—J&L's own staff in laboratories at Detroit and the famous Graham Research Laboratories at Pittsburgh.

Your J&L distributor is as near as your telephone. Call Western Union Operator 25 for the name of your J&L distributor of Consistent Quality stainless steel.


J&L — a leading producer of stainless steel and precision cold rolled strip steels



STAINLESS
SHEET • STRIP • BAR • WIRE

Circle 419 on Page 19

MACHINE DESIGN



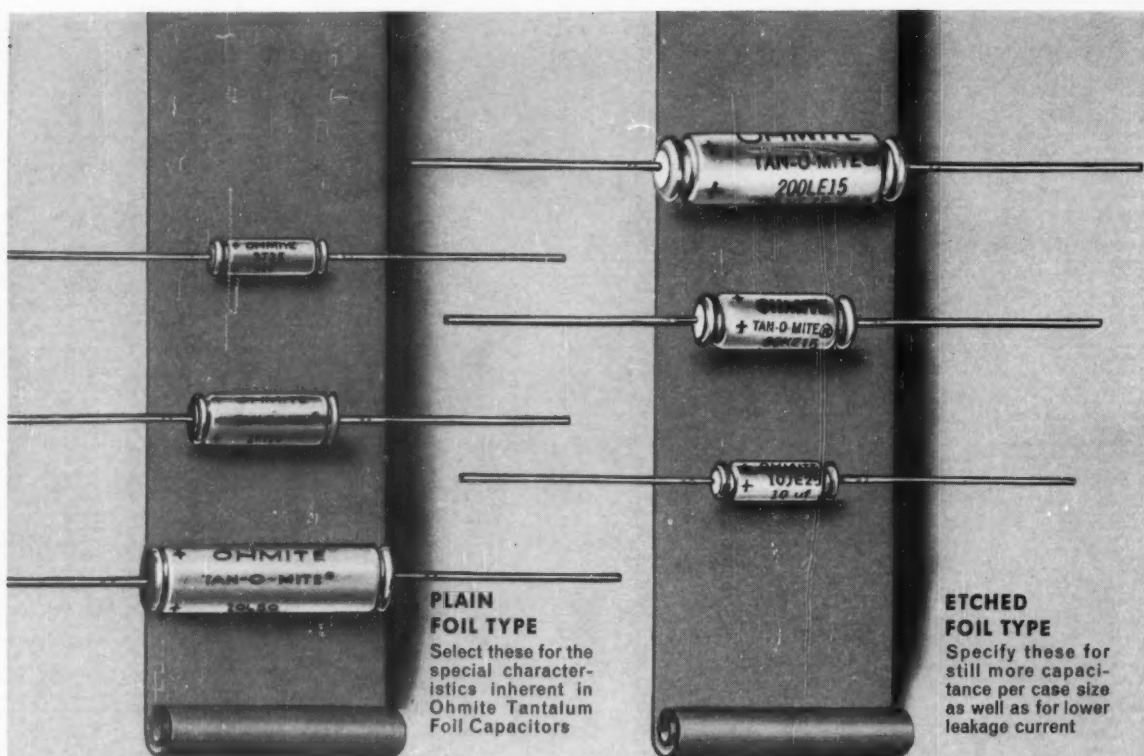
**consistent quality
production
depends on
consistent quality
stainless
steel**



Shafts of all types move from source
to point of use via J&L Consistent
Quality stainless steel pump shafts
and impellers.

★ **Call Western Union by number—ask for Operator 25
for the nearest source of Consistent Quality J&L Stainless Steel**

Jones & Laughlin Steel Corporation • STAINLESS and STRIP DIVISION • DETROIT 34



OHMITE TAN-O-MITE[®]

TANTALUM FOIL CAPACITORS ...

BOTH PLAIN AND ETCHED FROM STOCK

- 113 Stock Values
- Polar and Non-Polar Types
- Meets MIL-C-3965B: Insulated and Uninsulated Case Styles; All Vibration Grades
- Extra High Capacitance in Small Case Size
- Great Stability in Use or Storage
- Long Life—in Operation and Storage
- Operates in Wide Temperature Extremes
- Very Low Leakage Current and Power Factor

Write for Bulletin 152F



OHMITE MANUFACTURING COMPANY
3618 Howard Street, Skokie, Illinois

RHEOSTATS • RESISTORS • TAP SWITCHES
RELAYS • R.F. CHOKES • TANTALUM CAPACITORS
VARIABLE TRANSFORMERS • GERMANIUM DIODES

CONDENSED SPECIFICATIONS — Series TF

Construction Tantalum foil in metal cases sealed against atmospheric conditions. Plastic insulating sleeves optional.

Range Plain foil units, 0.25 to 140 mfd; etched foil units, 0.5 to 200 mfd. Working voltages range up to 150 VDC depending on capacitance.

Tolerances (120 cps, +25°C) Plain foil, $\pm 20\%$. Etched foil as follows:

less than 50 volts.....	$-15\% +75\%$
50-99 volts.....	$-15\% +50\%$
100-150 volts.....	$-15\% +30\%$

At extremes of operating temperature, the capacitance change meets MIL-C-3965B requirements.

Temperature Range Operation in ambients from -55°C to $+85^{\circ}\text{C}$.

Power Factor (120 cps, +25°C) Plain foil, 10-15% depending on voltage rating; etched foil, 15-20% depending on voltage rating.

Maximum DC Leakage Current Plain foil, 0.017 microamps/volt-mfd at 25°C ; 0.10 at 85°C . Etched foil, 0.01 at 25°C and 0.06 at 85°C .

Ceramic Gyro Promises "Infinite" Life

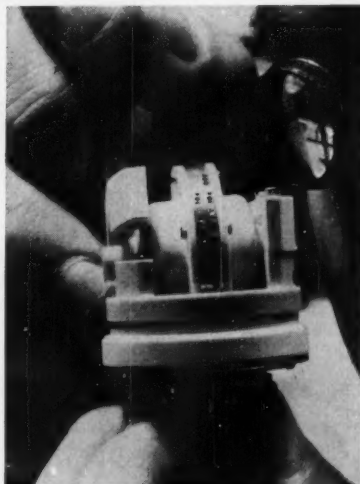
**Sapphire-Hard Material
Beats Start-Stop Wear**

MINNEAPOLIS—Ten times more accurate than gyros which guide today's long-range missiles, off-the-shelf models of a new ceramic gyroscope will be good enough for space-vehicle guidance.

Four years in development, the gyro awaited two research achievements: 1. A ceramic material as hard as sapphire that could be honed into precise shapes. 2. Development of a miniature ceramic self-generating gas bearing.

Combining hard ceramic with the gas bearing sharply reduces gyro-drift inaccuracies, report Minneapolis-Honeywell engineers who developed the device. The bearing, lubricated by a thin gas film, is virtually friction free. Until now, gas bearings have not been practical because of starting and stopping wear. However, the ultrahard ceramic eliminates these troubles. In test, bearings have been started and stopped thousands of times without any signs of wear. In addition, the ceramic increases stability of other gyro parts—especially the spin motor and gimbals.

Theoretically, the small gyro (2 in. diam by approximately 2-13/16 in. long) has a life span that ap-

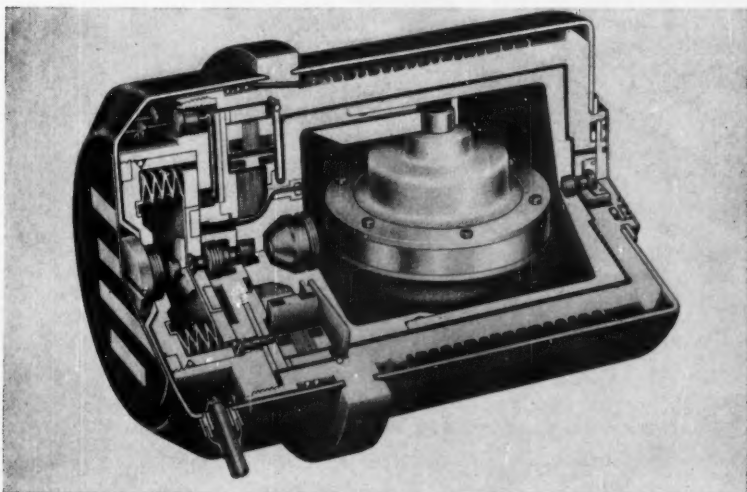


Jeweler's eyepiece dramatizes the size of the gyro. Except for the balancing ring (tiny drill holes correct unbalance) all parts are made from a virtually indestructible sapphire-hard ceramic.

proaches infinity. Light weight (8 oz) and machined to close tolerances (bearing clearance is only 25 millionths in.), it cuts vibration and bearing noise by a factor of 30, compared to ball-bearing gyros.

In stability tests, M-H engineers have subjected the ceramic to temperatures ranging from -85 to 1500 F. The material retains its

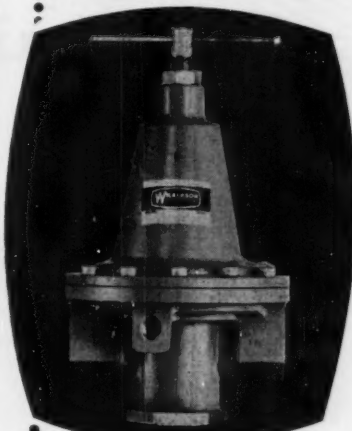
(Please turn to Page 42)



Bell-shaped part in the cavity is the ceramic motor. Spinning at 2400 rpm, it floats on a helium film 25 millionths in. thick. Ceramic components within the motor include end bells, spin rotor, shaft, and gimbal. The gyro weighs 8 oz.

Reliable accuracy!
Positive performance!

WILKERSON REGULATOR



NEWLY DESIGNED 3/4" & 1" sizes

- ★ Self-relieving in your choice of direct-operated or pilot operated models
- ★ Also available in 1/4" to 2" P.T.
- ★ Rugged Zamak body with Buna N and brass internal parts for long life
- ★ Non-chattering, balanced valve design
- ★ Low pressure drop, big ports and valve opening for large flow capacity
- ★ Larger diaphragm area regulates inlet pressure up to 300 PSI

SEND for Circular #1029a
for complete information on

- ★ Remote controls
- ★ Brackets
- ★ Tamper-proof kits
- ★ Lo & Hi pressure ranges

FREE →

New "1st Award"
Wilkerson catalog
#158 on complete
line of air products



WILKERSON
CORPORATION

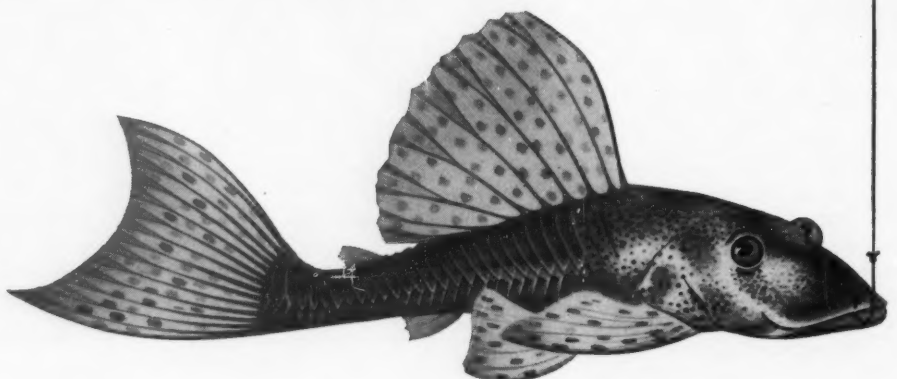
Dedicated to keeping the NEW in PNEUMATICS

1646 W. Girard
Englewood, Colorado

Circle 421 on Page 19



To build for rigidity...



Our crazy fish got caught and is bending the cast iron bar $2\frac{1}{2}$ times as far as if it had been steel. Don't you get caught too. Read this...





design for welded steel!

THAT'S RIGHT!!! Had you forgotten that mild steel is stiffer than cast iron—two-and-a-half times more rigid as a matter of fact. Remember their moduli of elasticity? 30,000,000 for mild steel. 12,000,000 for cast iron.

So, given two beams of equal section and length, each having the same load and moment, the cast iron will deflect $2\frac{1}{2}$ times as far as the steel. Or, put in a machine base of the same design, under load, the cast iron will deflect over twice as much—the steel being stiffer.

But, if you design for the required stiffness for the maximum allowable deflection, you can take advantage of steel's natural properties and welding's ability to place metal just where needed—to end up with not just a base of the same rigidity, but one which is also stronger and lighter.

With good design and proper fabricating facilities, you may even lower your costs 20-40%.

The LINCOLN Field Engineers are not designers. They will not pretend to be. But—for ideas on how you can apply welded design in your products, call in a LINCOLN Field Engineer. Or, to learn about the LINCOLN Design Seminars, write on your letterhead—and do it today!

THE LINCOLN ELECTRIC COMPANY

Dept. 2010 • Cleveland 17, Ohio



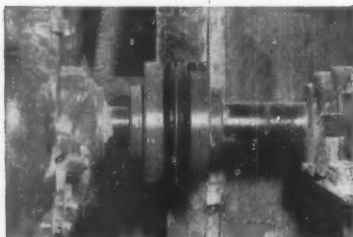
WOOD'S POWER TRANSMISSION PRODUCT NEWS



REVOLUTIONARY NEW VARIABLE

Revolutionary resilient cam follower construction of Wood's new "MCS" motion control, variable speed drives holds constant driven speeds under varying torque loads. Like the "MS," the "MCS" won't freeze or stick. Check oil only once or twice a year. Write for Bulletins 8102, 4101.

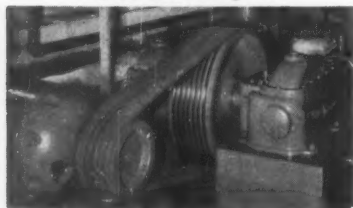
Circle 423 on Page 19



4-WAY FLEX—UNIQUE DESIGN

Wood's Sure-Flex Couplings absorb 5 to 15 times more shock and vibration than other leading flexible couplings... swallow all types and combinations of angular and parallel misalignment, endfloat. Simple, no wear, no lubrication. Low cost. Write for Bulletin 5103.

Circle 424 on Page 19



50% GREATER CAPACITY

New belt materials and manufacturing techniques give you 50% more horsepower from Wood's Sure-Grip V-Belt Drives. These drives are equipped with famous, interchangeable, tapered, QD-type Sure-Grip Bushings which feature standard and reverse mounting for greater adaptability. Write for Bulletin 197.

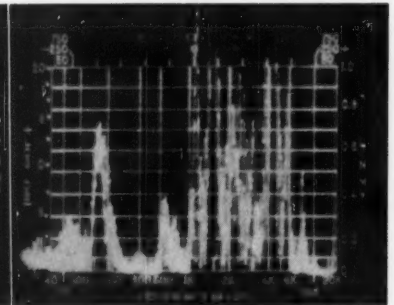
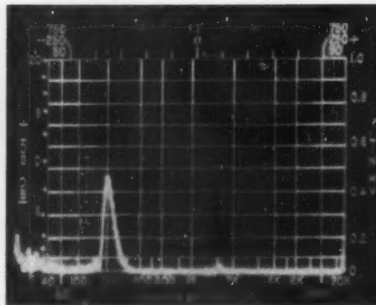
Circle 425 on Page 19



**T. B. WOOD'S SONS
COMPANY**

CHAMBERSBURG, PENNSYLVANIA
ATLANTA • CAMBRIDGE • CHICAGO
CLEVELAND • DALLAS

ENGINEERING NEWS



Oscilloscope traces from the ceramic gyro (left) show extremely low noise readings compared to ball-bearing gyros. By eliminating the balls and retainers, substituting viscous for hysteresis damping, and decreasing thermal-expansion deformations, M-H cut back noise and friction by a factor of 30.

(Continued from Page 39)

original dimensions within two millionths of an inch. Harder than ordinary grinding wheel materials,

the ceramic can be finish-ground to excellent surface finish and extreme accuracy—tolerances on some parts are less than 3 millionths in.

AGMA Bestows E. P. Connell Award

HOT SPRINGS, VA.—At the 44th annual meeting of the American Gear Manufacturers Association, E. J. Wellauer was named 1960 recipient of the Edward P. Connell award. This award is given to an individual who has made "outstanding personal contributions to further the art of gearing."

Mr. Wellauer, director of research and development of the Falk Corp., was cited "in recognition of his outstanding contributions to the development of the gear manufactur-

ing art, particularly in the field of gear strength and durability ratings."

An active AGMA member for many years, Mr. Wellauer currently serves as chairman of the Gear Rating Committee and as a member of several other committees. He is a graduate of Marquette University with degrees in mechanical and electrical engineering and has a master's degree in metallurgical engineering from the University of Wisconsin.

Meetings and Shows

Aug. 8-12—

American Institute of Electrical Engineers. Pacific General Meeting to be held at the El Cortes Hotel, San Diego, Calif. Additional information can be obtained from AIEE headquarters, 33 W. 39th St., New York 18, N. Y.

Aug. 14-17—

National Heat Transfer Conference, sponsored by the American Society of Mechanical Engineers and the American Institute of Chemical Engineers, to be held at the Statler

Hilton Hotel, Buffalo. Further information is available from Meetings Dept., ASME, 29 W. 39th St., New York 18, N. Y.

Aug. 16-19—

Society of Automotive Engineers Inc. National West Coast Meeting to be held at the Jack Tar Hotel, San Francisco. Further information can be obtained from SAE headquarters, 485 Lexington Ave., New York 17, N. Y.

Aug. 23-26—

Western Electronic Show and Convention to be held in the Memorial Sports Arena, Los Angeles. Sponsors are the Western Electronic Manufacturers Association and the

new Wood's selector charts simplify timing drive design



Now you can shelve the slide rule when you figure a timing belt drive installation. Engineers at T. B. Wood's Sons Company have developed a simplified design method that produces the right drive answers with almost no calculations.

This new method is contained in five easy-to-understand Selector Charts covering all timing belts from "extra light" to "double extra heavy." These new Selector Charts are a Wood's exclusive. For your free set, write for Bulletin 21103.

© Copyright, T. B. Wood's Sons Company, 1960

T. B. WOOD'S SONS COMPANY • CHAMBERSBURG, PA. • ATLANTA • CAMBRIDGE • CHICAGO • CLEVELAND • DALLAS

Institute of Radio Engineers. Additional information is available from Wescon headquarters, 1435 S. La Cienega Blvd., Los Angeles 35, Calif.

Sept. 6-16—

Production Engineering Show to be held at the Navy Pier, Chicago. Further information can be obtained from Clapp & Poliak Inc., 341 Madison Ave., New York 17, N. Y.

Sept. 6-16—

National Machine Tool Builders Association. Machine Tool Exposition to be held at the International Amphitheatre, Chicago. Additional information is available from Clapp & Poliak Inc., 341 Madison Ave., New York 17, N. Y.

Sept. 7-9—

Joint Automatic Control Conference to be held at Massachusetts Institute of Technology, Cambridge, Mass. Sponsors are Instrument Society of America, American So-

ciety of Mechanical Engineers, American Institute of Electrical Engineers, Institute of Radio Engineers, and American Institute of Chemical Engineers. Additional information can be obtained from ISA, 313 Sixth Ave., Pittsburgh 22, Pa.

Sept. 7-15—

Second Coliseum Machinery Show to be held in the Chicago Coliseum. Further information is available from A. Byron Perkins & Associates, 2807 Sunset Blvd., Los Angeles 26, Calif.

Sept. 12-13—

Material Handling Institute Inc. Fall Meeting to be held at the Cavalier Club, Virginia Beach, Va. Further information is available from Hanson & Shea Inc., 1 Gateway Center, Pittsburgh 22, Pa.

Sept. 12-15—

Society of Automotive Engineers Inc. National Farm, Construction, and Industrial Machinery Meeting, including production forum and engineering display, to be held at the Milwaukee Auditorium, Milwaukee.

Additional information can be obtained from SAE headquarters, 485 Lexington Ave., New York 17, N. Y.

Sept. 15-16—

American Society of Mechanical Engineers. Engineering Management Conference to be held at the Morrison Hotel, Chicago. Additional information can be obtained from Meetings Dept., ASME, 29 W. 39th St., New York 18, N. Y.

Sept. 19-20—

Steel Founders' Society of America. Fall Meeting to be held at the Homestead, Hot Springs, Va. Additional information is available from society headquarters, 606 Terminal Tower, Cleveland 13, Ohio.

Sept. 21-23—

American Society of Mechanical Engineers-American Institute of Electrical Engineers Power Conference to be held at the Bellevue-Stratford Hotel, Philadelphia. Further information is available from Meetings Dept., ASME, 29 W. 39th St., New York 18, N. Y.



Mr. W. C. Guent, Jr. of Master Etching Company, Wyncote, Pa. says:

"General Electric's Polydyne® Drive Adds Three Important Sales Features To Our Product"

Accurate speed control, wide speed range and fast speed-changing capabilities mean time savings and better printing plates for users of Master Etching Machine Company's powderless etcher.

These features, along with compact size, low maintenance and operating simplicity, have made Polydyne drives the EXCLUSIVE choice of Master Etching Company for the mechanical adjustable speed drive on their model M-32 etcher.

With Polydyne drives you can get a wide range of process speeds and adapt machine speed to meet requirements of different operations with fewer machines—straight from a-c power.

Why not investigate the advantages of using a Polydyne drive on your equipment? Polydyne

drives are available from ¼ to 25 hp with output speeds from 4200 to 5 rpm in a wide variety of configurations and enclosures.

For more information, contact your G-E Apparatus Sales Office or Distributor, or write for Bulletin GEA-6806, Section 854-04, General Electric Co., Schenectady 5, N. Y.

Progress Is Our Most Important Product

GENERAL  ELECTRIC

Short Courses and Symposia

July 7-8—

Seminar on Low-Cost Automation to be held at Pennsylvania State University will cover use of pneumatic control in industry, development of a hydraulic circuit for automating a machine, application of relays for automation, static switching systems, state of the art in small U. S. industries, and applications in European industry. Additional information can be obtained from the Conference Center, The Pennsylvania State University, University Park, Pa.

July 11-15—

Institute in Technical and Industrial Communications to be held at Colorado State University. Purpose is to provide counseling and basic and advanced instruction in technical writing and related communications. Additional information is available from the director of the Institute, Colorado State University, Fort Collins, Colo.

July 18-22—

Survey course on radioisotope principles and techniques, designed to increase management understanding of basic concepts, to be held at the University of California at Berkeley, with the co-operation of the U. S. Atomic Energy Commission. Further information can be obtained from the Engineering and Sciences Extension, University of California, 2451 Bancroft Way, Berkeley 4, Calif.

July 24-29—

Research and Development Management Development Seminar, to help middle management representatives develop skills in administration and human relations, to be held at Pennsylvania State University. Additional information can be obtained from the Continuing Education Conference Center, The Pennsylvania State University, University Park, Pa.

Aug. 1-19—

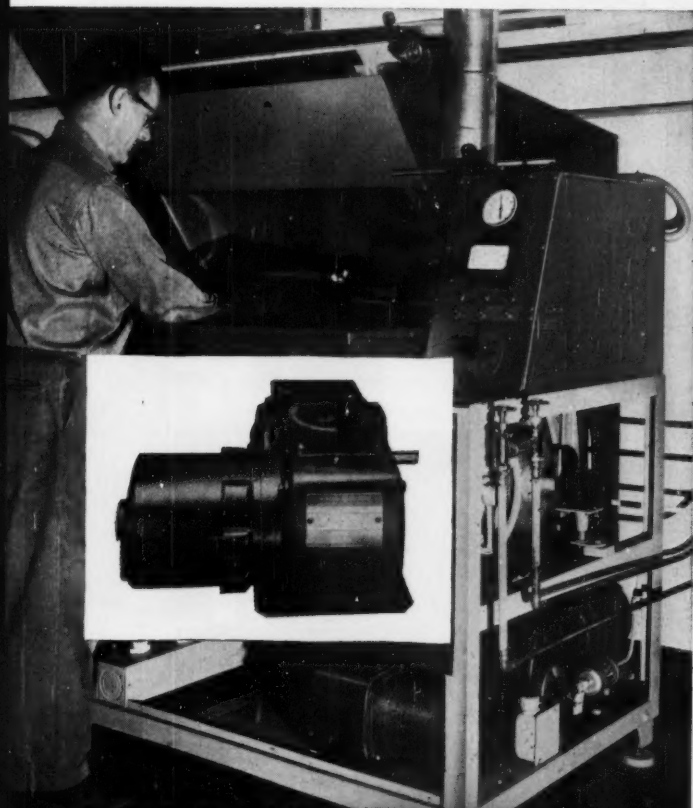
1960 Statistical Methods in Industry Program, including courses in quality control by statistical meth-

ENGINEERING NEWS

ods and in industrial reliability, to be held at the University of California. Fifteen-day courses in design and analysis of industrial experiments and in basic measurements and standards (including nondestructive testing) will also be offered. Additional information can be obtained from Prof. Edward Coleman, Department of Engineering, University of California, Los Angeles 24, Calif.

Aug. 22-26—

Thermonuclear Plasma Physics Symposium, to be held in Gatlinburg, Tenn., will deal with elementary aspects of achieving controllable release of energy in significant amounts from thermonuclear fusion reactions. Sponsors are Oak Ridge National Laboratory (operated by Union Carbide Corp.) and the Oak Ridge Institute of Nuclear Studies, in co-operation with the U. S. Atomic Energy Commission. Further information can be obtained from the laboratory, P. O. Box X, Oak Ridge, Tenn.



Compact, low maintenance General Electric Polydyne drive (insert) gives the Master Etching Machine a wide speed range and accurate speed control—features that build strong customer preference.

General Electric Offers a Complete Line of Low-speed Drives 1/8 to 200 HP

Select from G.E.'s PLUS LINE of compact mechanical power transmission equipment! A full range of ratings is available—many directly from stock.



General Electric
Polydyne Drive



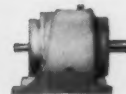
Integral-type
Gear Motor



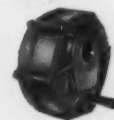
Right-angle Shaft
Gear Motor



All-motor
Gear Motor



Footed Speed
Reducer



Shaft-mounted
Speed Reducer

General Electric would like to help solve your specialty mechanical power transmission problems.

For further information write:

Mr. C. R. Anderson, Mgr. Product Planning, Gear Motor & Transmission Components Department, 845 E. 25th Street, General Electric Co., Paterson, N. J.

Member of American Gear Manufacturers' Association

GENERAL ELECTRIC

emblem of a new era .



. . in die casting

IT'S TIME TO RE-EVALUATE YOUR DIE CASTING SOURCES!

Periodically American industry gains another springboard for progress through the reorganization of a long-established firm to provide increased capabilities, better services and improved products. Precision Castings Company, Division of Precasco Corporation, one of the Fulton Industries, Inc. group offers an outstanding example.

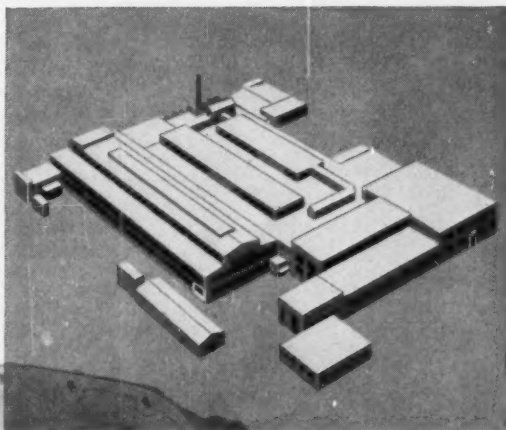
The aggressive programs being carried out at Precision lead the way into a new era of die casting... and a new era of benefits.

A streamlined corporate structure puts fresh emphasis on customer service. Relocated field offices extend this service. Accelerated research is finding ways to meet the requirements of the '60's, and beyond.

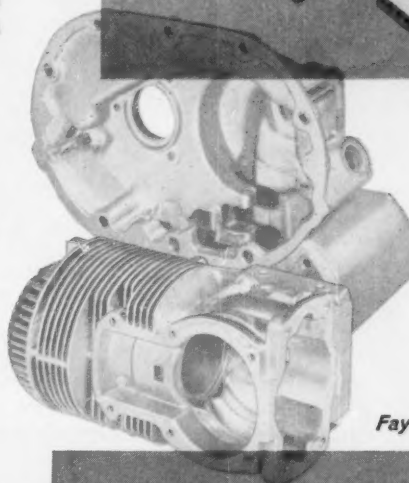
Realigned operating management insures a new high order of quality control, and improved traffic both in and out of Precision's plants.

Progressive modernization of all production equipment enables us to provide better-made, better-finished products.

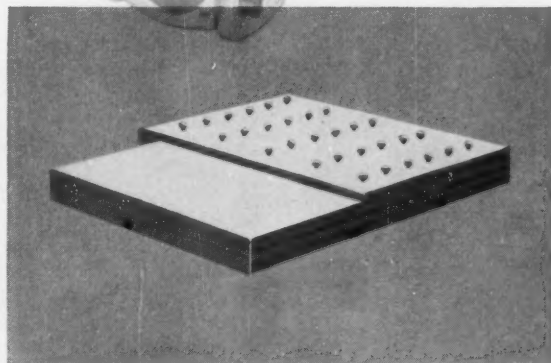
Thus, our new hallmark signifies the dynamic force and broadened scope of the new Precision Castings Company... producing the finest zinc and aluminum die castings for *precision-minded* manufacturers.



Cleveland, Ohio



Fayetteville, New York



PRECISION CASTINGS COMPANY

DIVISION OF PRECASCO CORPORATION

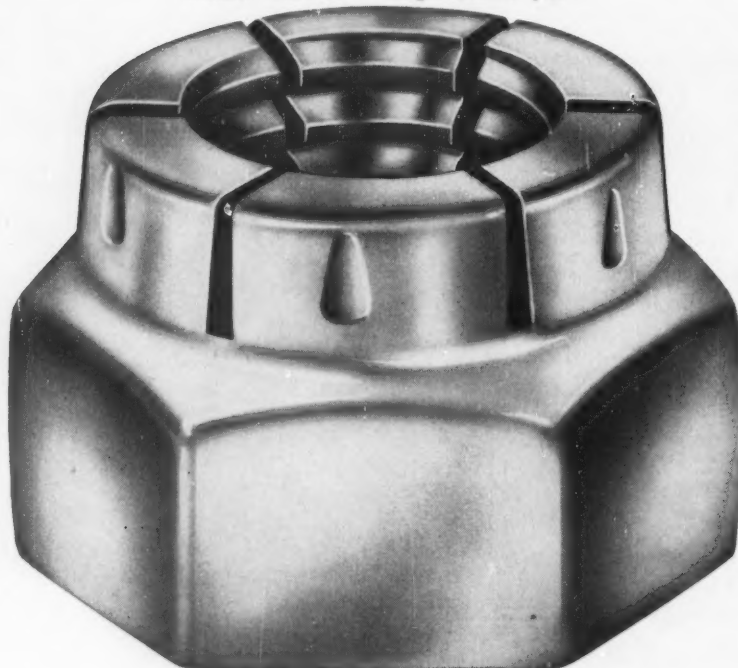
CLEVELAND, OHIO • FAYETTEVILLE, N. Y.

Stays put . . . for keeps

FLEXLOC

Put FLEXLOCs on your assemblies and relax. They're going to stay put . . . "for keeps" . . . regardless of the shock, the pounding, the vibration. These self-locking nuts simply won't work loose.

With the 1-piece all-metal FLEXLOC, no lockwashers, jam nuts, cotter pins, or other auxiliary locking devices are needed. There's nothing extra to put



together, come apart or get lost. Assembly time and costs are reduced. And maintenance expenses are cut, because FLEXLOCs can be readily removed, repeatedly reused.

One more major FLEXLOC feature: they lock seated or not once $1\frac{1}{2}$ threads of the bolt are past the top of the FLEXLOC.

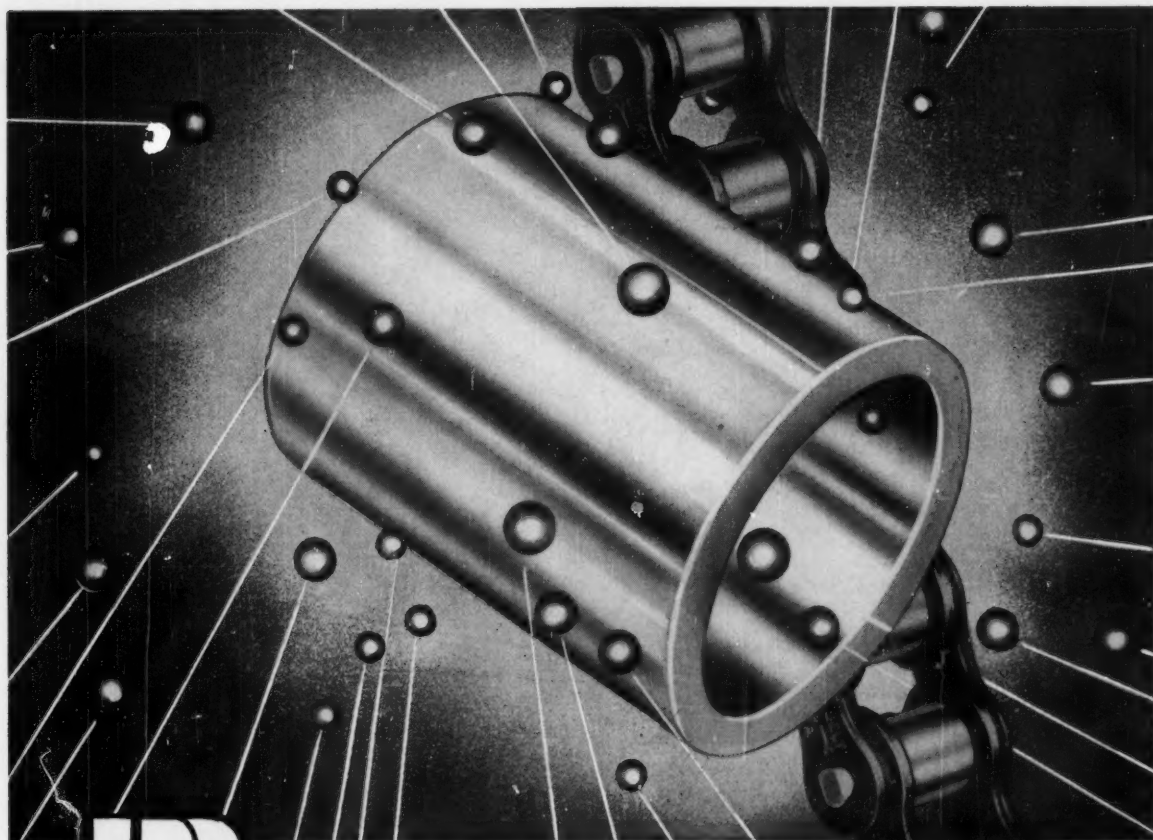
So insist on FLEXLOCs and keep your assemblies operating at full efficiency . . . full time. See your authorized industrial distributor for complete information on sizes, materials and finishes. Or write SPS—manufacturer of precision threaded fasteners and allied products in many metals.

INDUSTRIAL FASTENER Division

JENKINTOWN 18, PENNSYLVANIA

SPS

where reliability replaces probability



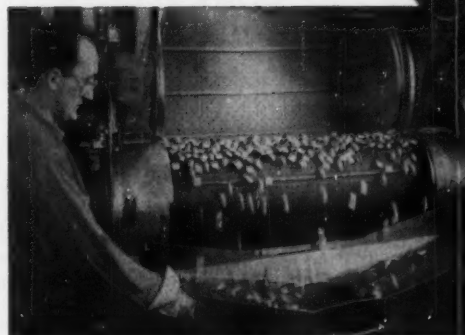
Rollers

fortified against fatigue

Shot-peening "cold-works" extra fatigue life into LINK-BELT roller chain

Shot-peening gives rollers of Link-Belt precision steel roller chain exceptional strength and stamina. And after shot-peening, they are burnished rather than ground or sanded. This achieves a SILVER-BRITE finish—and more important, retains the fatigue resistant qualities of shot-peening.

Other long-life "extras" of Link-Belt roller chain include: close heat-treat control, lock-type bushings, pre-stressing, pitch-hole preparation. For details, see Book 2657.



LONG LIFE AHEAD! Rollers for Link-Belt precision steel roller chain tumble out of shot-peening machine after being cold-worked to withstand punishment of today's high-speeds and heavy loads.

LINK-BELT

ROLLER CHAINS AND SPROCKETS

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices and Stock Carrying Distributors in All Principal Cities. Export Office, New York 7; Australia, Marrickville (Sydney); Brazil, Sao Paulo; Canada, Scarborough (Toronto 13); South Africa, Springs. Representatives Throughout the World.

18,082



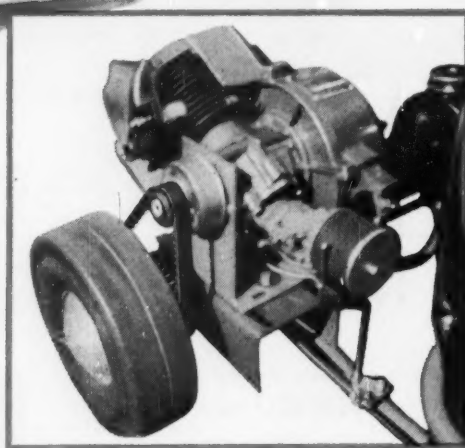
BOOK 2657 has 154 pages of roller chain data. For your copy, contact your nearest Link-Belt office. (See CHAINS in the yellow pages of your phone book.)



PowerGrip "TIMING" BELTS from the Power Unlimited complete belt line



Even the youngsters
are making time with
the U.S. PowerGrip
"Timing" Belt



Howard Industries, Inc. (Sumter, S. C.) use the U. S. PowerGrip "Timing"® Belt to get perfect transmission response on the Go-Karts they manufacture.

Says Howard E. Short, president, "This car is being raced with gratifying results by children and adults. The U. S. PowerGrip "Timing" Belt provides positive transmission of power. Our engine is a 2½ h.p., 2-cycle chain saw engine turning up at 6200 r.p.m.

"U. S. PowerGrip "Timing" Belt drives made it possible to economically convert this motor for installation in the Go-Kart. Since "Timing" Belts are fixed drives, they need no maintenance or adjustment and they whiz the Go-Kart

along at speeds of 35 to 60 miles per hour, depending on the drive ratio."

U. S. PowerGrip "Timing" Belts with speeds ranging to 16,000 r.p.m. and up to 1000 h.p. have made possible not only the efficiency of the Go-Kart, but literally the design and production of hundreds of appliances and equipment, ranging from sensitive electronic devices, office machinery, household equipment and gigantic production machinery.

One way to get expert transmission counsel is from the U. S. Rubber Distributor. He's your best on-the-spot source of technical aid, quick delivery and quality industrial rubber products.



Mechanical Goods Division

United States Rubber

WORLD'S LARGEST MANUFACTURER OF INDUSTRIAL RUBBER PRODUCTS

Rockefeller Center, New York 20, N.Y.

In Canada: Dominion Rubber Company, Ltd.

and they run
and they run
and they run

1903—

Indianapolis.
a trolley car.
a rolling adventure surrounded by noise.
pennies, nickels, children . . .

and inside—
a Fairbanks Morse electric motor.
it drove the trolley over thousands of miles
and rode with it
into glorious retirement.

pick a year—
from the turn of the century until now.
pick a month,
pick a day,
pick a city,
pick a town—
our motors are in its history . . .
pulsing, driving, working.
powering the things we need
and the things we want.
pushing our daily advances.
pulling us into the future.

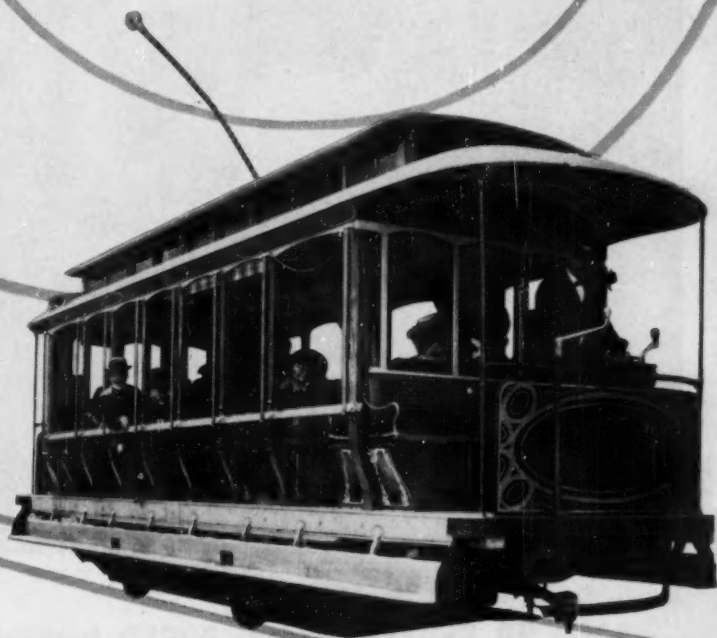
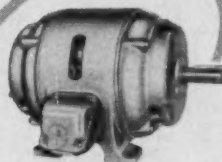
today our electric motors
are bigger and better.
they're also smaller and stronger,
surer and more powerful.

they operate in air and underground,
in freezing temperatures and underwater,
in gas-filled areas
and radiation atmosphere.

they power oil burners and compressors,
elevators and fans,
pumps, conveyors and saws.

they are adaptable
to every phase of every industry
for many reasons and more purposes.
they keep us growing
and they keep us improving.
they keep us ahead of the day before
and on the heels of the day ahead.

they are our heartbeats
and they run and they run and they run.

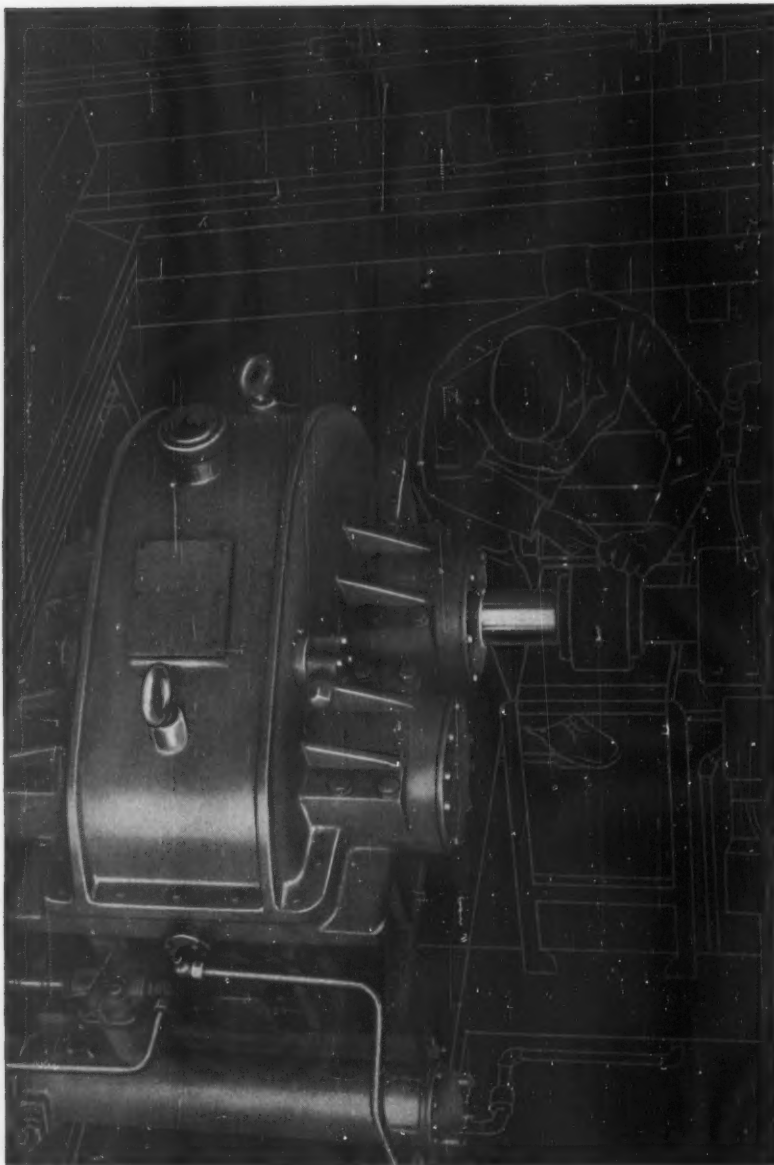


Fairbanks, Morse

A MAJOR INDUSTRIAL COMPONENT OF FAIRBANKS WHITNEY CORPORATION

The electric motor is one of the most versatile sources of power ever developed. It is economical, practical and time-resistant. Fairbanks-Morse electric motors can turn out $\frac{1}{8}$ horsepower or 10,000 horsepower, meet every known job demand within this range or be custom-specified to your blue-print projections. Whatever your production needs or plans may be, our electric motors can power them.

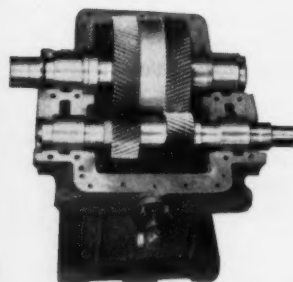
If you are in a field where power for production must be efficient, effective and dependable—we suggest that you consider our great variety of electric motors. For further information please write to: Mr. George H. Herrick, Vice President and General Manager, Electrical Division, Fairbanks, Morse & Co., Freeport, Illinois.



2000 HP Philadelphia HI-SPEED Increaser drives man-made hurricane . . .

Wind tunnel testing of missile and aircraft models at supersonic speeds demands exacting performance and extremes of endurance for all equipment involved. At Cornell Aeronautical Laboratory, Inc., this 2000 HP Philadelphia Increaser drives a modified jet engine compressor for developing tunnel air speeds of 600 to 1500 mph. Operation is on a continuous, round-the-clock basis . . . often for extended periods of time.

IMPROVED GEAR ACCURACIES MEAN HIGHER SPEEDS, LESS WEAR



With today's demands for higher speeds, problems of service life become much more critical. And there is only one solution . . . more accurate gearing. Specifically, Philadelphia Gear Drives equipped with precision ground gearing.

This development is so significant you can solve drive problems you could never solve before . . . because you get engineering advantages never available in standard drives . . . at commercial prices.

Longer life is only one advantage however. Improved gear accuracies also mean significant increases in load carrying capacity. Sound levels are reduced to the point where gear noise will never be a problem, even on applications where low sound levels are important.

Precision ground gearing reduces backlash in reversing drives and provides uniform backlash where precision of movement is important. Interchangeability, too — duplicate gearing can be installed with original manufacturing tolerances duplicated . . . exactly.

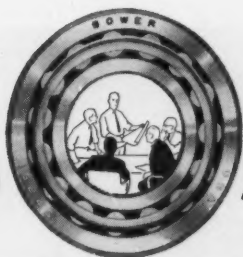
Standard Philadelphia HI-SPEED drives are designed for speeds to 10,000 rpm at pitch line velocities to 10,000 fpm. Horsepower ranges from 1 to 7100 HP. Ratios from 1:1 to 10:1 for high speed reduction or increase. Exact specified ratios are furnished within 1/2%.

Send for more information about Philadelphia HI-SPEED Increasers. Offices in all principal cities. Or write directly to:

PHILADELPHIA GEAR CORPORATION

King of Prussia, Pennsylvania
(Suburban Philadelphia)

philadelphia gear drives

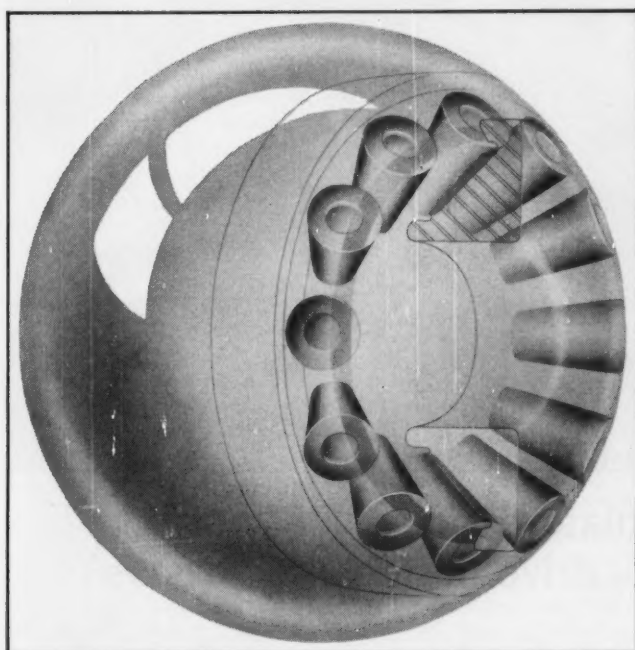


One in a series of technical reports by Bower

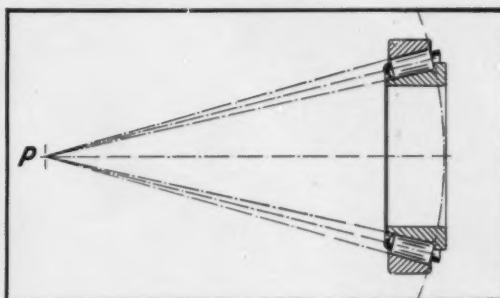
BEARING

BRIEFINGS

SPHERICITY — ESSENTIAL TO MAXIMUM BEARING PERFORMANCE



When you require bearings, we suggest you consider the advantages of Bower bearings. Where product design calls for tapered or cylindrical roller bearings or journal roller assemblies, Bower can provide them in a full range of types and sizes. Bower engineers are always available, should you desire assistance or advice on bearing applications.



True rolling of tapered bearing elements depends upon maintaining a true spherical radius during manufacture.

For a tapered roller bearing to achieve maximum performance, i.e., maximum life and capacity under load, it must have true sphericity — a condition of bearing geometry which permits true rolling of the tapered rollers in the raceway.

True rolling in tapered bearing elements is the result of maintaining a critical geometric relationship between the raceways and the contact surfaces of each roller. True rolling is essential to maximum performance. Without it, premature bearing failure is certain.

As engineers know, a tapered roller will describe a true circle when rolled on a plane surface. It will always roll in this one path precisely, without sliding or skewing. But to put true rolling to work in a bearing which can carry both heavy thrust and radial loads, it is essential that the rollers and the raceway have a true

spherical radius, or sphericity. The drawing illustrates this condition.

If each roller in the bearing were to be extended in length, while retaining its taper, it would form a cone, terminating at point "P". All cones generated from all rollers would meet at point "P", which is also the center of the hypothetical sphere shown. The surface of the sphere would touch all points on each roller's head!

In effect, then, each roller's taper determines the radius of a hypothetical sphere

whose surface, in turn, determines the correct contour for each roller head. Only when these conditions are satisfied in design, and when they are rigidly held during manufacture, will true rolling take place. In the manufacture of each Bower tapered roller bearing, sphericity is held within extremely narrow limits by means of special Bower-designed precision grinders. The consistent accuracy possible with these machines is one major reason why Bower roller bearings provide maximum performance under all speeds and loads up to the bearing's maximum rating.

BOWER ROLLER BEARINGS

BOWER ROLLER BEARING DIVISION — FEDERAL-MOGUL-BOWER BEARINGS, INC., DETROIT 14, MICHIGAN



NEW Cramer miniatures for military use record elapsed time, - drive positioning devices

TYPE 620 Elapsed Time Indicator (top) shown approximately full scale, is offered for operation on 115 volt, 60 or 400 cycle power. Dimensionally, the version illustrated meets MS-28053 and NEMA standards, and is front-panel mounted through a 1-19/32" diameter opening. All relevant test requirements of MIL-M-7793B and MIL-E-5272B are met or exceeded (to 50 G's shock, 2000 cycle vibration). An optional back-panel mounting adapts to existing panel drilling. Hermetically sealed, Type 620 has recessed solder lugs at rear for electrical connections. Total registration 9,999.99 hours, weight about 4 ounces. Designed primarily for military use, the unit will give unsurpassed service in rugged industrial applications.

TYPE 120 Miniature AC Motor (right) is rated 115 volts, 60 cycles. Permanent-magnet design assures fast response

and truly synchronous operation. Running torque .08 inch ounce at 240 rpm rotor speed, weight approximately 2 ounces.

TYPE 821 Ungoverned DC Motor (bottom) for no-load speeds from 8,000 to 20,000 rpm. Typical 28-volt armature develops 14,200 rpm no-load, 12,600 rpm at 0.1 inch ounce load, with current drain about 100 ma. Weight under 2 ounces. Meets MIL-T-5422E.

TYPE 890 115-Volt 400-Cycle Motor (left) is a single-phase hysteresis-synchronous motor. Available as basic 3/8" motor (like Type 120 at right), or in 1-inch flange-mounted can illustrated, containing motor and capacitor network. Produces .01 inch ounce torque at 3000 rpm. Weight under 2 ounces.

Write for complete information, specifications.

ELECTROMECHANICAL DIVISION

CRAMER CONTROLS CORPORATION

CENTERBROOK, CONNECTICUT

MACHINE DESIGN



Dow Corning

SILICONE NEWS

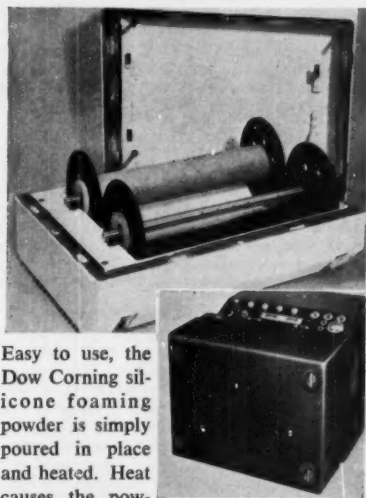
for design and development engineers • No. 75

A FOAMED - IN - PLACE SILICONE PROTECTION

Engineers at Consolidated Electrodynamics Corporation have found a foam-in-place silicone resin ideal for protecting the magazines of oscillographs used to gather vital data during dynamic testing studies of variables affecting aircraft performance.

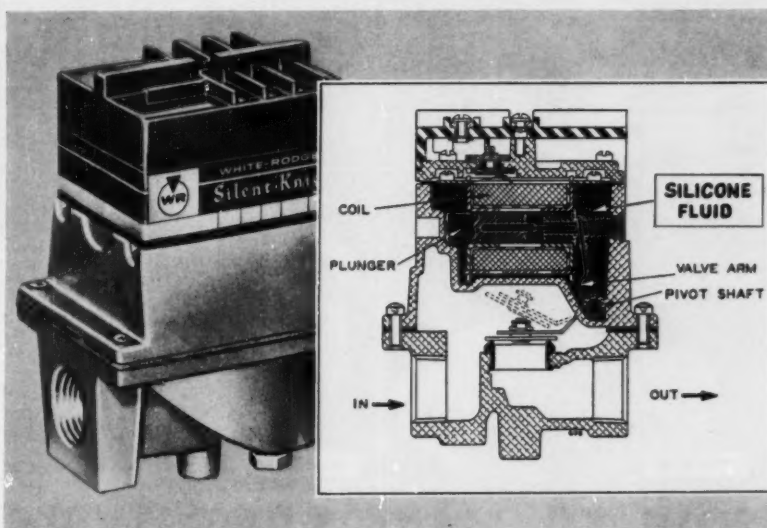
CEC's Recording Oscillographs are capable of simultaneously making permanent photographic records of up to 50 factors affecting performance. These instruments record information in terms of electric current and catalog all phenomena in true relation to time and to one another.

To be certain that these critical data will be preserved for study through all eventualities, even when experimental aircraft must be ditched, CEC designed and built the first effective crash-resistant storage magazine. The magazine is housed in a ductile-iron casting surrounded by a stainless steel shell. It's protected against heat and shock by a silicone resin foam that fills the space between casting and shell.



Easy to use, the Dow Corning silicone foaming powder is simply poured in place and heated. Heat causes the powder to melt and foam, completely filling the void. Additional protection is provided by painting the outer steel shell with a fire resistant paint that foams at 300 F.

How effective is the Dow Corning silicone foam? CEC estimates the magazine will withstand a shock of 400-g's followed by a fire as hot as 2,000 F! In addition, the magazine is explosion-proofed in accordance with MIL-E-5400 A (ASG). No. 241



SILENCES GAS VALVES

Use of silicone fluid has enabled White-Rodgers Company, St. Louis, to produce gas valves that give completely silent service on such units as central heating, floor and wall furnaces, conversion burners, boilers, unit heaters and room circulators. Here's how:

White-Rodgers' engineers effectively eliminated operating noises by immersing the entire operating mechanism of the new Silent Knight Gas Valves in Dow Corning 200 Fluid. Enclosed in an unbreakable metal case, the viscous fluid slows the mechanism, cushions the components and makes them silent. Eliminated are the characteristic "snap" of the relay, the "hammering" of the plunger. In addition, by damping the opening action of the

valve, some of the undesirable "pop" of the gas ignition is eliminated.

Silicone fluid proved the ideal damping medium because it doesn't thicken or thin with temperature changes, thus assuring consistent, uniform damping far beyond the capabilities of previously available damping oils. This fluid's noncorrosiveness and resistance to oxidation and to breakdown under shear assures long-time reliable service.

What's more, Dow Corning 200 Fluid's remarkable thermal stability helped simplify the design and increased the reliability of the gas valve by eliminating the need for rubber diaphragms or bellows in the fluid chamber. No. 242

THE BETTER TO "SEE" WITH...SILICON

Optical silicon, now available from Dow Corning, enables infrared surveillance and detection devices to home on heat waves . . . to put missiles on target.

Crystalline ingots, domes, prisms and flats produced by Dow Corning for such use are held to less than two parts impurity per 100 million. Infrared optics attained by proper grinding, polishing and coating of optical silicon provide more than 95% transmission of a signal of any desired wavelength between 1.3 and 6.7 microns, have excellent light gathering power.

Dow Corning optical silicon crystals show excellent heat stability and shock resistance. Their abrasion resistance, chemical stability, light weight and strength are other desirable features. No. 243

PROPERTIES OF DOW CORNING OPTICAL SILICON

Melting point	1420 C
Hardness	7 Moh
	1150 Knoop
Thermal conductivity	0.39 cal/cm-sec-°C
Thermal expansion	4.15 x 10 ⁻⁶ /C°
Flexural strength	20,000 psi

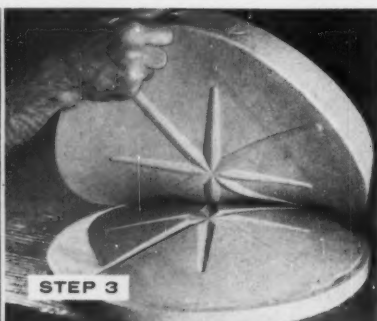
FOR DATA RELATING TO THESE ARTICLES, CIRCLE REFERENCE NUMBER IN COUPON ON NEXT PAGE
OR REFERENCE NUMBER ON READER SERVICE CARD

MORE

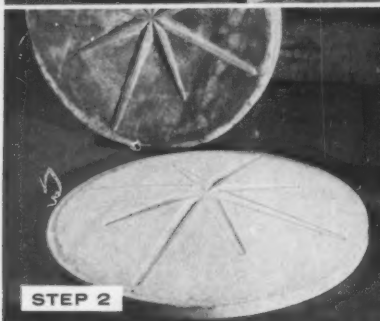




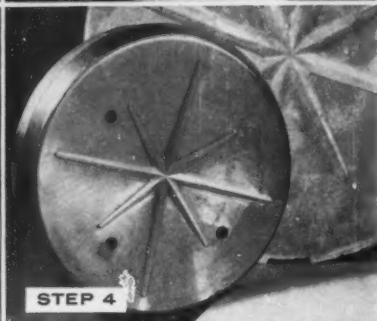
STEP 1



STEP 3



STEP 2



STEP 4

HOW TO MAKE PROTOTYPES

Silastic® RTV provides a new and better way to make prototypes. Here's how one automotive parts supplier—Cadillac Stamp Company, Detroit—uses this Dow Corning room-temperature-vulcanizing silicone rubber to make templates for hubcap embossing dies.

STEP 1. Silastic RTV is poured onto a wood pattern machined to the exact configuration of the hubcap design. With its fluid consistency, Silastic RTV flows into and around complex shapes and intricate and deep draws—then vulcanizes at room

temperature to produce a strikingly accurate "negative" mold.

STEP 2. A plastic "positive" of the original pattern is then cast in the Silastic RTV mold. This "positive" forms a prototype from which a pantograph-type engraving machine can sink female dies.

STEP 3. Next, more Silastic RTV is poured into the original silicone rubber "negative" mold made of Silastic RTV to form another RTV "positive". After this new charge has vulcanized in the mold the two are separated. Coating the mold with a release agent facilitates clean and quick separation of the new "positive".

STEP 4. A plastic form is now cast from the Silastic RTV "positive". This plastic template is used in guiding the engraving machine in producing male sink dies. In this process, size is reduced by one-half.

An economy feature: Thanks to Silastic RTV both embossing dies are made from one wood original.

For more information, circle . . . No. 244

NEW ENGINEERING GUIDE

A 16-page compilation of information on properties and applications of silicones used by design and production engineers in all fields. To obtain your complimentary copy, circle No. 245



See how silicones can help you! See how you can use them to advantage in virtually every industry.

Dow Corning movies, that are yours for the asking, portray the roles different forms of silicones play in different engineering and design applications.

Each is a 16 mm, full color, sound movie. Each is available at no charge for showing to your engineering group.

To learn more about arranging for a showing of any of the movies described below, circle the corresponding number on the coupon or reader service card.

You And The Silicones — This 30 minute documentary film depicts the story of silicones in dramatic full color. Shown are their versatile forms, unique properties, and countless applications in bakeries, power plants, dairies, chemical plants, shops, automobiles, jet planes and missiles, and even in the kitchen and swimming pool. This movie shows how silicones have made possible new designs and changes in equipment for industry, home, and military . . . No. 246

Rubber From Rock — See for yourself how Silastic, the Dow Corning silicone rubber, is made . . . how it is used to make good products better, from aircraft to nursing bottles. See how parts made of Silastic stay flexible over a wide temperature span; withstand long exposure to ozone, corona and weathering; remain dielectric materials after exposure to flame at 2000 F. A complete visual story about Silastic . . . No. 247

Silastic RTV — In just 14 minutes, you can see the entire story of this ready-to-use fluid silicone rubber that effectively resists weathering, moisture, oxidation, shock and vibration. Learn how effectively and quickly you can make prototype molds and parts. The versatility of this room temperature vulcanizing rubber is limited only by a designer's imagination. See RTV in use. No. 248

More Muscles For Tomorrow — The story of silicone electrical insulation is told in this full color, sound movie. It explains how you can increase life and reliability, attain up to 50% greater service factor in electric equipment systems insulated with Dow Corning Silicones. See how silicone insulation contributes to greater miniaturization, increases power per pound ratio . . . cuts maintenance and downtime. No. 249

Dow Corning Corporation, Dept. 4906, Midland, Michigan

Please send me: 241 242 243 244 245

246 247 248 249

NAME _____

TITLE _____

COMPANY _____

STREET _____

CITY _____ ZONE _____ STATE _____

SILICONE NEWS is published for design and development engineers by



Dow Corning CORPORATION
MIDLAND, MICHIGAN

ATLANTA BOSTON CHICAGO CLEVELAND DALLAS LOS ANGELES NEW YORK WASHINGTON, D. C.

CANADA: DOW CORNING SILICONES LTD., TORONTO GREAT BRITAIN: MIDLAND SILICONES LTD., LONDON FRANCE: ST. GOBAIN, PARIS

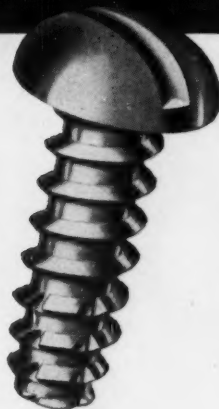
FOR DATA RELATING TO THESE ARTICLES, CIRCLE REFERENCE IN COUPON ABOVE,
OR REFERENCE NUMBER ON READER SERVICE CARD

Got a problem that calls for thread-cutting screws?

PARKER-KALON offers three new, improved thread-cutting screws for every application in every material



1 New, Improved P-K Type F*
... hardened thread-cutting screws developed for use in friable, granular or brittle material. The pilot, with its five tapping flutes, cuts a machine screw thread as the screw is turned in. The Type F is ideal for making fastenings to ferrous and non-ferrous castings, bronze or brass forgings, heavy gage sheet metals, structural steels, plastics and resin-impregnated plywood.



2 "Pentap"... the new, Improved P-K Type B-F*
(formerly F-Z) combining the five thread-cutting flutes of the Type F screw with the coarse-pitch, widely-spaced threads of the P-K Type B. The thread-cutting "Pentap" Type B-F distributes cutting pressure evenly, lets chips drop to the bottom of the hole, and prevents cracking of material. It is designed for making fastenings to comparatively thin sections and bosses in friable and brittle plastics.



3 P-K® Type L†
... is a completely new and improved thread-cutting screw developed by Parker-Kalon especially for use in Nylon. The Type L functions as a combination thread-cutting and thread-forming screw in that it cuts a small amount of the Nylon to allow the full diameter threads to form. Type L offers a particular advantage in Nylon assemblies which must be disassembled for service, because the P-K Type L can be removed and replaced without stripping or galling.

The five cutting flutes on the new, improved P-K Type "F" and "BF" reduce pressure development by 80 percent! The completely formed threads on these screws have sharper cutting edges, and 5 deep flutes that are of continuous depth. These features make for better clearance of the accumulated material and assure minimum stresses in driving, and avoid the possibility of stripping or galling.



FOR SEMS... and Neoprene or Nylon washer STAPS* in thread-cutting and thread-forming tapping screws, or machine screws in any kind of pre-assembled fastener-washer combination, P-K can supply them, too!

FOR SAMPLES OF P-K THREAD-CUTTING SCREWS AND SEMS, CALL YOUR LOCAL P-K "BULK-STOCKING" DISTRIBUTOR

PARKER-KALON® fasteners

PARKER-KALON DIVISION, General American Transportation Corporation, Clifton, New Jersey • Offices and Warehouses in Chicago and Los Angeles

KEEP AMERICAN INDUSTRY AT WORK... BUY P-K... MADE IN U.S.A.

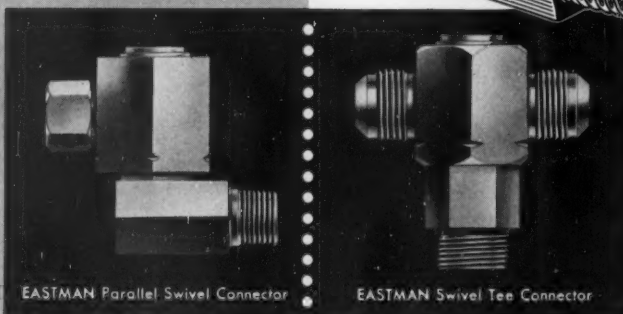
*Patent Pending U. S. Patent 2,350,348



Licensed Under
Pat. No. 2481404

AMAZING VERSATILITY AND ADAPTABILITY!

These two adaptations, specified by two of America's largest major equipment manufacturers, reveal the unique adaptability and versatility of EASTMAN'S Improved Industrial Swivel Connector.



EASTMAN Parallel Swivel Connector

EASTMAN Swivel Tee Connector

improves SEALING QUALITY

through use of SIX seals, thereby eliminating failure from grit, dust and other foreign materials.

improves SERVICE LIFE

through new design and engineering, the interior is chrome-hardened with a highly polished mirror finish.

improves UNIFORMITY OF FLOW

at any angle of the swivel by undercutting the shaft to equal diameter of the orifice.

improves SERVICEABILITY

through shorter, more compact housing; saving weight. Hex design permits multiple tapping on housing; easier assembly.

While the use of EASTMAN'S High Pressure Industrial Swivel Connector eliminated the cause of hose failure due to constant, extreme flexing, it tended to increase the load on the swivel connector.

To improve the performance of the swivel itself, EASTMAN engineers improved its internal design, chrome-hardened its interior surfaces, cadmium plated the shaft and then machined them to a mirror-like finish.

Satisfactory service under the most unfavorable field conditions was insured by increasing sealing rings from four to SIX: 2 leather dust seals, 2 synthetic back-up washers and 2 quad rings of oil-resistant rubber (-65° to $+250^{\circ}$).

Exhaustive tests at 3000 p.s.i., through one million cycles, with the hydraulic fluid saturated with abrasives, dirt and other foreign materials, proved EASTMAN'S Industrial Swivel Connector satisfactory in every respect and did not cause failure of any kind.

That is why America's leading OEM's and replacement buyers specify *complete* EASTMAN Hydraulic Hose Assemblies... for improved design, quality manufacturing and exhaustive testing. It pays to specify EASTMAN.

STANDARD SIZES AND COMBINATIONS AVAILABLE

LOW TORQUE—Freedom from friction, even under high pressure.

WIDE RANGE—Operating pressures up to 5000 p.s.i. trouble-free operation through wide temperature range (-65° to $+250^{\circ}$).

ROTATION—Full 360° for all manifolds.

SIZES—Steel, plated for corrosion protection— $\frac{1}{2}$ ", $\frac{3}{4}$ ", 1", 1 $\frac{1}{4}$ ".

Other sizes available on request.

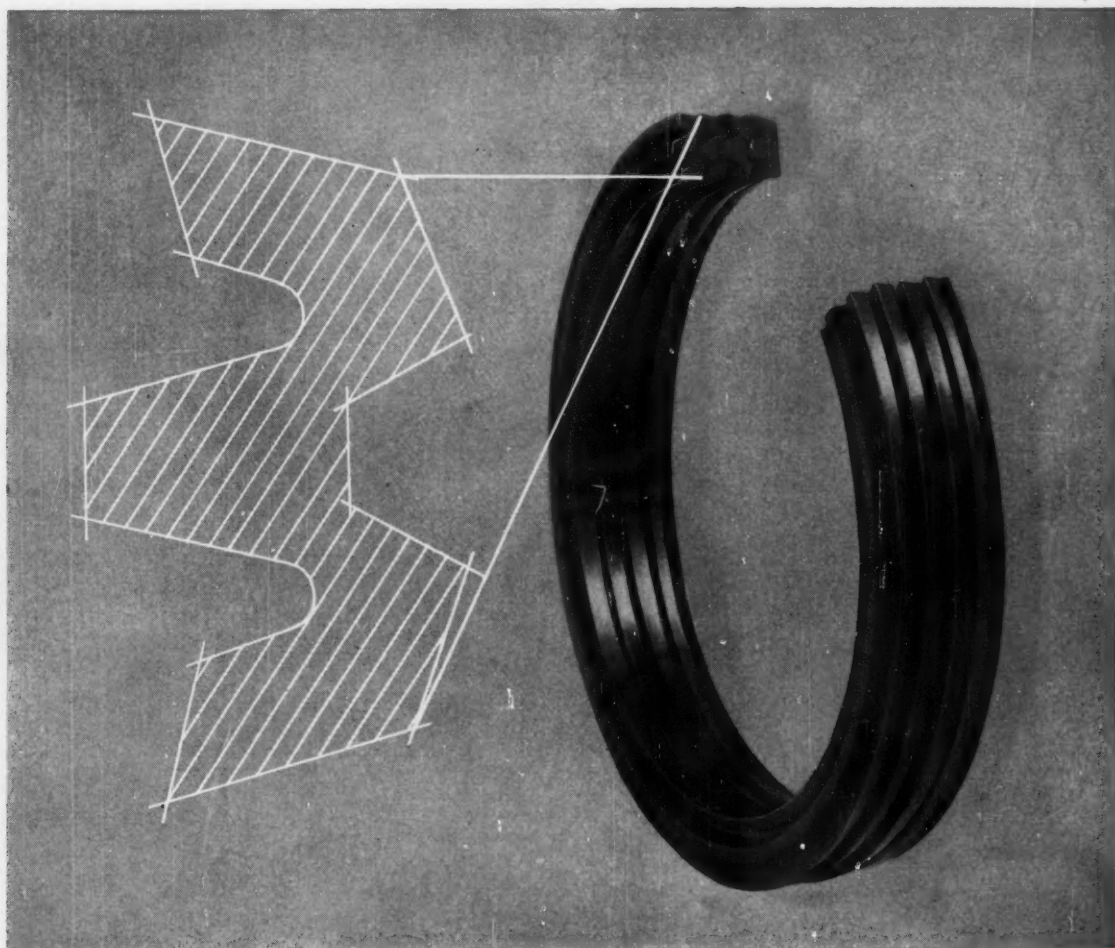
**LOOK INTO
EASTMAN'S IMPROVED
SWIVEL CONNECTOR—
WRITE TODAY!**

Please send me Bulletins 100 and 200 on low, medium and high pressure assemblies.



Eastman

MANUFACTURING COMPANY
DEPT. MD-6, MANITOWOC, WISCONSIN



Smaller stuffing boxes made possible with J-M UNEEPAC®

**THIS UNIQUE CROSS-SECTION
SHOWS WHY UNEEPAC AFFORDS
FULLY AUTOMATIC SEALING
IN LIMITED SPACE**

Because Uneepac offers compact design and greater efficiency...smaller stuffing boxes and fewer rings are required to seal against the most rugged conditions!

These fully automatic, self-centering and self-adjusting packings are pressure-actuated. They are easy to assemble...are quickly installed...fit accurately...reduce friction...give exceptional service life in rod and piston applications.

Skillfully compounded in what-

ever materials best meet your requirements, J-M moulded packings are engineered with the workmanlike care and precision for which Johns-Manville is known throughout industry. They are specifically designed to give you top performance and optimum economy for every packings dollar you spend.

There is a broad selection of J-M moulded packings specifically engineered for hydraulic and pneumatic applications. A complete range of all standard sizes, styles and materials

is available for immediate shipment. Or J-M will custom-make and design the exact packing that will give you the best, most economical service.

You'll find complete information in free booklets PK-126 A and PK-148 A, which present all J-M moulded packings materials and designs, with specific recommendations for most applications and service conditions. See your J-M Distributor. Or write to Johns-Manville, Box 14, New York 16, N. Y. In Canada: Port Credit, Ontario.

JOHNS-MANVILLE



New Super-Roadpacker is world's highest capacity vibratory compactor. Shown in operation on Ohio Interstate Route 1, it uses two 15-foot rows of vibrating shoes to compact roadbuilding materials at variable speeds best suited to the job.



vibration/shock/noise control for construction colossus

Center Bonded Mountings protect pump engine, oil reservoir and fuel tank

Plate Form Mountings protect two instrument panels

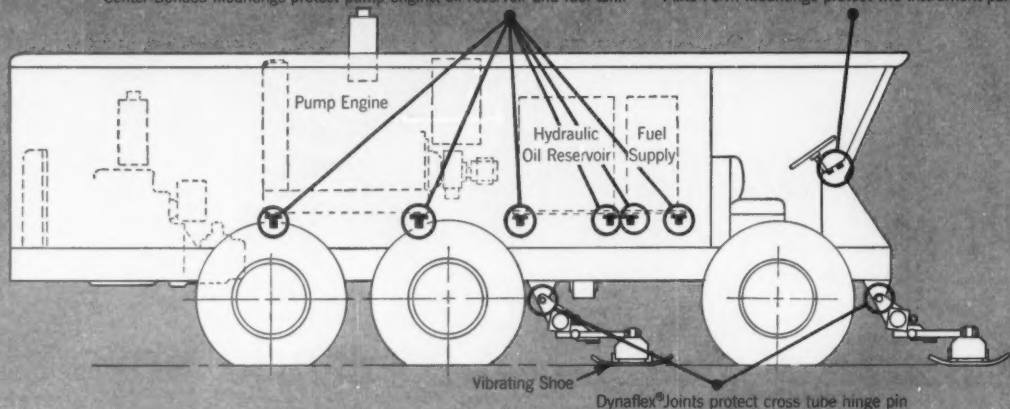


Photo courtesy Baldwin-Lima-Hamilton Corp.

This roadbuilding giant compacts soils by delivering 2200 blows per minute through its 12 vibrating shoes. The resulting disturbances could seriously damage vital components of the Super-Roadpacker. But LORD Mountings and Joints with controlled flexibility prevent damage by isolating vibration, attenuating shock and reducing wear.

Once again the benefits of engineered protection against shock and vibration are realized through better performance, longer service life and less maintenance.

Designers of equipment exposed to harsh jolts, vibration, distortion or misalignment can upgrade product quality with LORD vibration/shock/noise control. Proved benefits result when you use LORD elastomeric units at critical points—engines, radiators, batteries, hoods, cabs, seats, instrument panels, fuel tanks, transfer cases, load equalizers, radius rods.

Utilize LORD capabilities to solve your problem. Contact your nearest LORD Field Office or the Home Office, Erie, Pa.



FIELD ENGINEERING OFFICES

ATLANTA, GEORGIA - Cedar 7-9247
BOSTON, MASS. - Hancock 6-9135
CHICAGO, ILL. - Michigan 2-6010
DALLAS, TEXAS - Riverside 1-3392
DAYTON, OHIO - Baldwin 4-0351
DETROIT, MICH. - Diamond 1-4340
KANSAS CITY, MO. - Westport 1-0138

LOS ANGELES, CAL. - Hollywood 4-7593
NEW YORK, N. Y. (Paramus, N. J.)
New York City - Bryant 9-8042
Paramus, N. J. - Diamond 3-5333
PHILADELPHIA, PA. - Pennypacker 5-3559
SAN FRANCISCO, CAL. - Exbrook 7-6280
WINTER PARK, FLA. - Midway 7-5501

"In Canada—Railway & Power Engineering Corporation Limited"

LORD MANUFACTURING COMPANY • ERIE, PA.

custom tailoring
costs less than
"ready-to-wear"



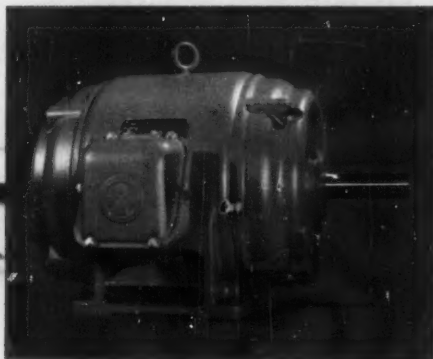
Buying an electric motor with "ready-made" insulation can be a costly luxury.

Motor operating conditions vary so widely throughout industry that Fairbanks-Morse insulation systems are *tailored* to actual operating conditions . . . not *standardized* to "the average".

"Ready-made" insulation systems are an "across-the-board" compromise with *average* operating conditions. When *your* case is the all-too-frequent exception, the compromise is costly.

Even in "hard to fit" cases we build motors rated, dimensioned and insulated to furnish unfailing power. Insulating materials are carefully tested, selected, treated and prepared so that insulation as well as motor enclosure is *matched* to the job. Entire insulation system is custom tailored to meet emergency overloads, temperature extremes, corrosive atmospheric conditions . . . whatever combination of factors affects motor life and performance of your *specific* operation.

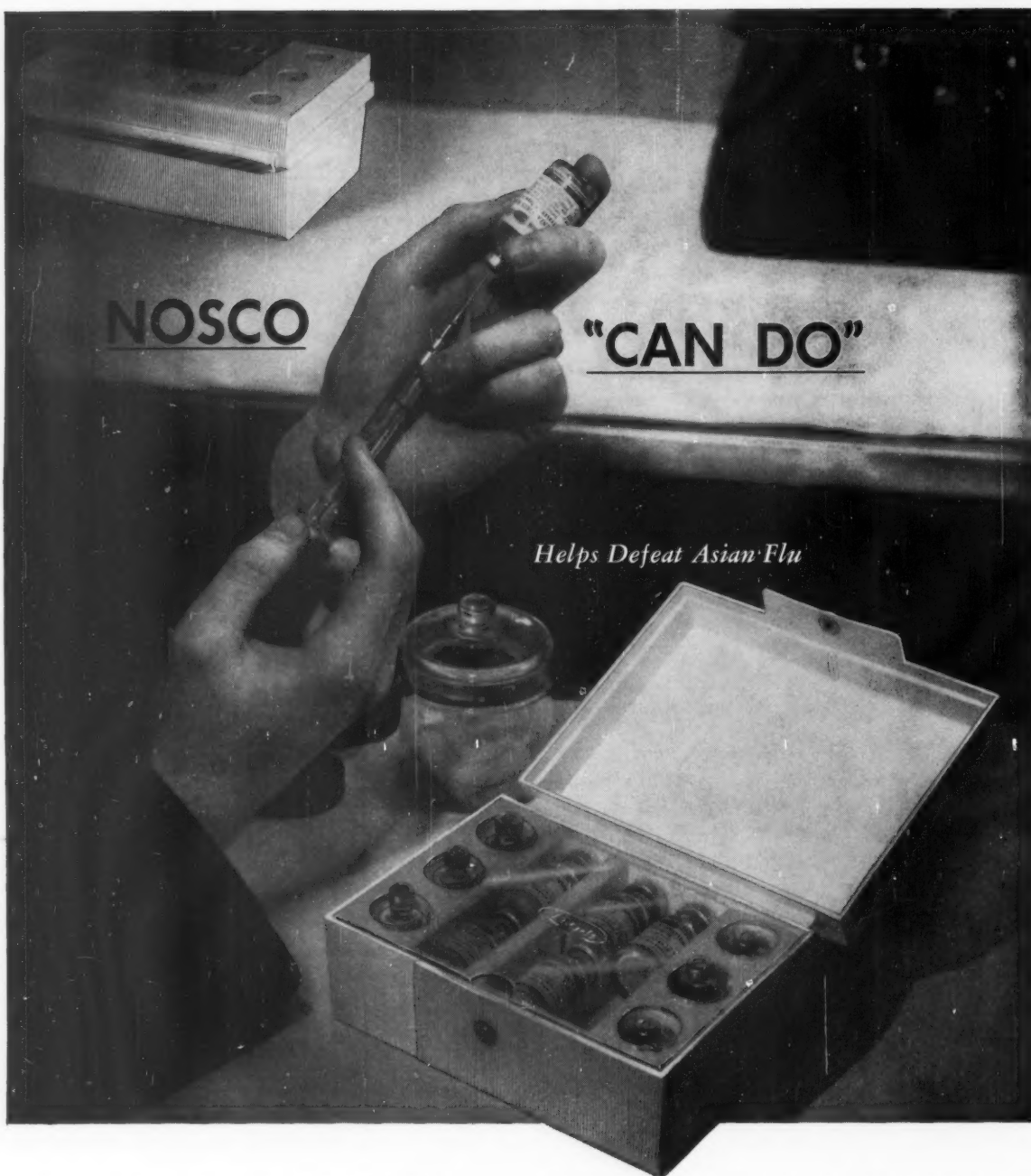
This *flexible* application of varied insulating materials and processes "pays off" in low maintenance, uninterrupted production, prolonged service.



Whatever your motor needs . . . 1 hp or 10,000 hp . . . open or weather-protected . . . vertical or horizontal . . . synchronous or induction . . . AC or DC . . . Fairbanks-Morse builds it, builds it right, builds it to last. Get the facts . . . drop a line today to: Fairbanks, Morse & Co., Freeport, Illinois.

Fairbanks, Morse
ELECTRICAL DIVISION

A MAJOR INDUSTRIAL COMPONENT OF FAIRBANKS WHITNEY CORPORATION



NOSCO

"CAN DO"

Helps Defeat Asian Flu

Yes, Nosco's famous "Can Do" ingenuity is contributing to a healthier America. Where doctors are fighting Asian Flu, you'll find this custom-molded Nosco Biological Kit by their side.

Lederle Laboratories wanted to make their precious flu vaccine easier for doctors to preserve and transport. They came to Nosco with their special requirements for a multi-vial carrying case. The container had to demonstrate striking clinical cleanliness and easy washability. Great shock resistance and chemical inertness were also necessary. And cost was important.

Nosco said "Can Do" and began transforming customer specifications into practical design. From flexible polyethylene they molded the container with an integral hinge for connecting the base and cover. A white expandable styrene liner was assembled

into the base to give additional shock and thermal insulation. Further protection is provided for the vials by the clear acrylic panel, which hinges freely with the case by means of integral pivot lugs.

Nosco's finishing department hot stamped "BIOLOGICALS" into the cover and crimped male and female eyelet elements into the case. Finally, the assembled composite units were individually plastic-bagged to preserve the clinical quality.

Complex projects like this biological kit are routine at Nosco. In injection molding and decorating, Nosco "Can Do" is time tested. Let us show you how these skills can produce your plastic parts in volume and at reasonable costs. For more information, just write or call.

NOSCO plastics, inc. • Erie 2, pa. *One of the world's great injection molders.*

the

neg'ator®

sketchbook

The NEG'ATOR® Spring is a new basic mechanical component—a coiled band spring which extends many times its original size without the increasing force common to conventional springs. Used as an extension spring, a motor, band, clamp, or clip, this revolutionary new constant-force component upsets all previous spring principles by doing what springs have never done before.

THREE TYPES OF SPRING MOTORS COMPARED

With the NEG'ATOR® constant-torque motor and a derivative, the SPIR'ATOR® close-to-constant-torque motor, Hunter has provided design engineers with two mechanical drive units of unique capabilities.

In addition, using materials and techniques developed in manufacturing NEG'ATOR springs, Hunter has been able to better the performance of, and add life to, the conventional and familiar power spring.

This family of three comprises Hunter *spring power*—dependable, powerful motors capable of storing and releasing rotational energy for infinite applications where light weight, constant or easily controlled torque, portability, simplicity, and low cost are important.

From these three spring motors, illustrated in Fig. 1, engineers can select the type which best meets individual application requirements. Here are some brief characteristics of each.

Power Springs

The power spring (or clock spring, spiral spring, or mainspring) is compact, relatively powerful, easy to apply. Since stress build-up is cumulative, so is energy storage. As a result, the moment delivered decreases throughout unwinding from a maximum at full wind to zero at run-down. This characteristic may be desirable in certain applications since the spring can be designed to deliver a particular moment at a certain position. Using new techniques, Hunter has increased the capabilities of this type of spring by bettering performance and adding to its life. See Fig. 2 for comparison with the other types.

(continued on reverse of this page)

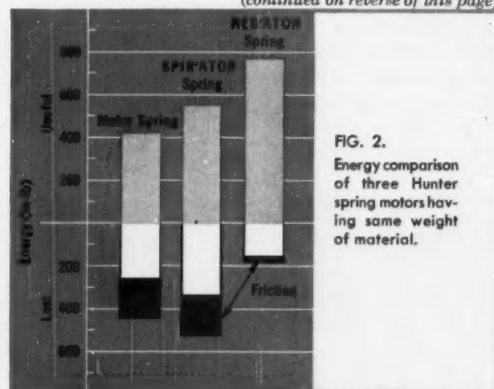
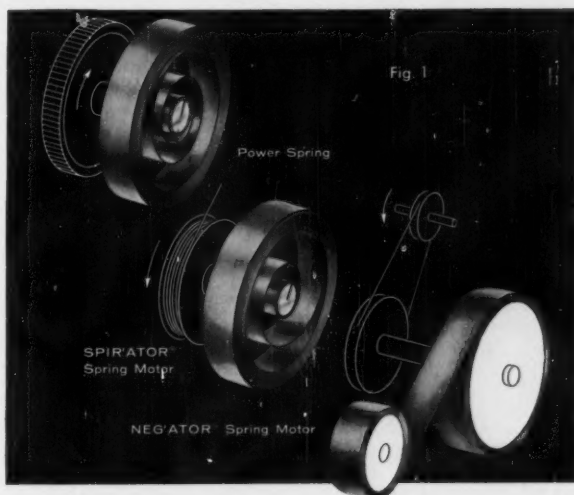


FIG. 2.
Energy comparison
of three Hunter
spring motors having
same weight of
material.



A Few NEG'ATOR® Motor Applications

MOVIE CAMERAS . . . practically every major manufacturer now uses a NEG'ATOR or SPIR'ATOR motor as the drive unit for movie cameras.

RECORDING INSTRUMENTS . . . a water level recorder and recording parachute tensiometer are two typical applications where light weight, constant torque, and long run are imperative.

VALVES . . . one manufacturer uses the NEG'ATOR motor to provide power for positive valve closure. Such motors can also be used to assist opening and closing against loads.

TIMERS . . . used as a timer reset mechanism, the constant-torque output of this type of motor provides sufficient force for tripping switches even at full run-down.

ACCESSORIES . . . a camera accessory manufacturer used the compactness feature of the SPIR'ATOR motor in creating a mechanical fading and dissolving device. The motor rotates one of two filters through 90°—occupies little space in this attachment for movie camera lenses.

FIELD-OPERATED TOOLS . . . in one such application, a multiple NEG'ATOR motor delivers 60 lb.-in. torque to drive the cutting head compass of a field-operated flame cutting machine a full 1½ turns with full force throughout travel.

(continued from reverse of this page)

THREE TYPES OF SPRING MOTORS COMPARED

SPIR'ATOR® Motors

These prestressed spiral springs by Hunter are related to the power spring and NEG'ATOR spring. They look like power springs—are made like NEG'ATOR springs. SPIR'ATOR motors are very compact, powerful, easy to apply, and produce as much as twice the length of running cycle in the same size package as a power spring. Torque is close-to-constant. Some lubrication is required.

NEG'ATOR® Motors

These unusually long-running motors release the maximum useful energy and provide constant-torque output from full-wind to run-down. Because of this, gearing can be reduced or eliminated and governors and associated components can be greatly simplified since they need not sustain excessive torques, and constant speed can be achieved using less complicated governor devices. NEG'ATOR motors need no lubrication. They provide many more turns than any other spring motor, are compact, easy to apply, are very powerful, and will not jump or skip.

Energy Comparison

To compare these three spring motors, refer to Fig. 2, an energy comparison of Hunter motor springs. Engineers who want a detailed discussion of "spring power" are invited to write to Hunter for a copy of "Motor Springs . . . A Comparison of Compact, High-Deflection, Spring-Energy Sources."

From the Designer's Sketch Pad

MOTORS FOR MOVIE CAMERAS

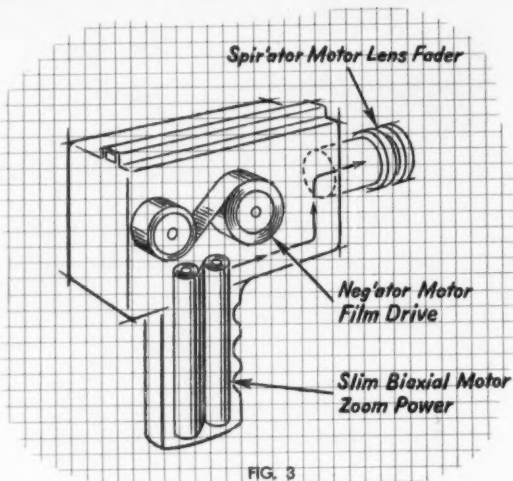
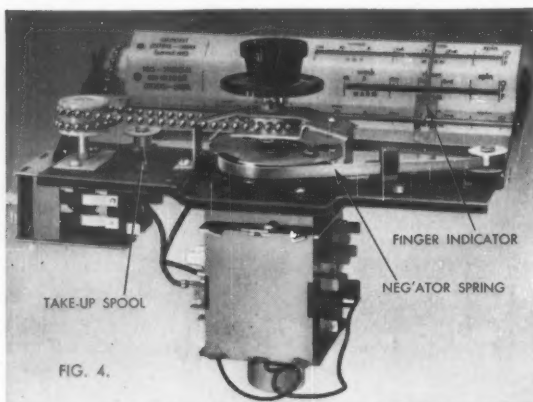


FIG. 3

The movie camera, being portable and hand-operated, provides many opportunities to use spring power. The sketch above is a composite showing how Hunter mechanical drives can be used in such a device. Here, a NEG'ATOR motor is used as a film drive. A SPIR'ATOR motor is used as a lens fader operator. A "zoom" lens is powered by a "slim biaxial" NEG'ATOR motor concealed in a pistol-grip handle.

CONSTANT-FORCE SPRING SOLVES RESET PROBLEM

Design engineers at Westinghouse Electric Corporation's Laundry Equipment Division greatly simplified a design problem with the long NEG'ATOR extension spring shown in Fig. 4.

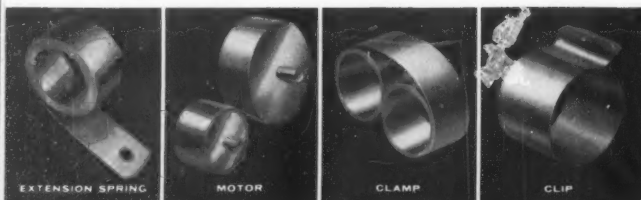


HS546S—3M—560D8

The spring, made from stainless steel .0035 in. thick x .250 in. wide x 25 in. long, acts as an automatic reset for the dial indicator of the "Laundromat" timer. As shown, one end is attached to the small take-up drum at left. The other end is attached to the larger drum, center. The finger indicator is crimped to the spring.

An electrical timer controls the washing cycle. When "on," it drives the larger drum, winding the extended end of the NEG'ATOR spring on it, through various washing operations to "off" position, a travel of 5 inches. A clutch disengages the electric motor and permits the NEG'ATOR spring to recoil from the large to the small take-up drum, returning the indicator to zero position.

The NEG'ATOR spring, which replaced a manually-operated rotary dial, is ideal for this application because of its constant $\frac{1}{4}$ lb. force throughout its travel and because of its long length and flexibility. A conventional, positive-gradient spring would build-up excessive force in the length of travel required and would overload the timer motor.



HUNTER SPRING COMPANY

A Division of American Machine and Metals, Inc.

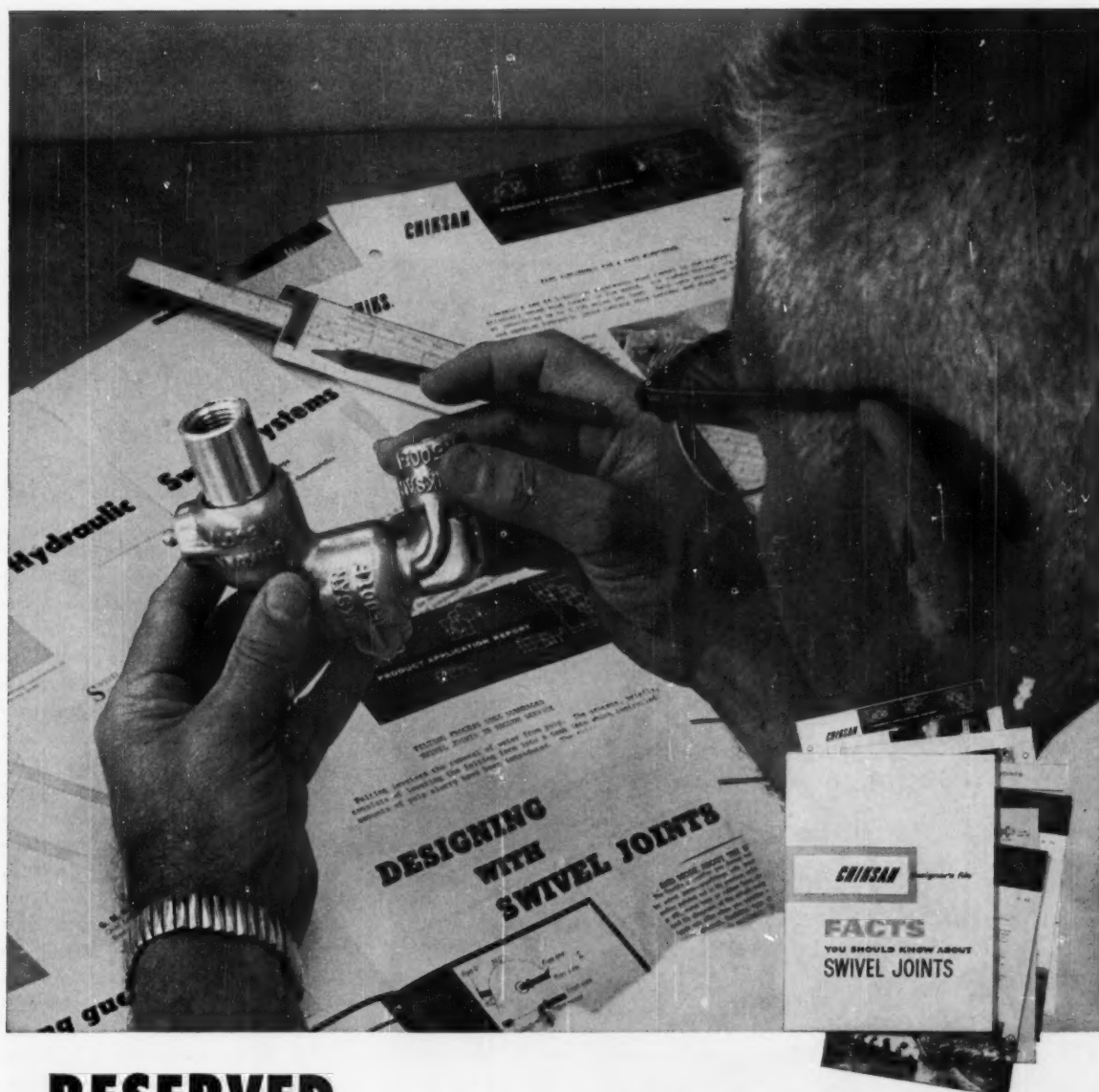
29 Spring Avenue, Lansdale, Pennsylvania

SPRINGS • STAMPINGS • QUALITY CONTROL EQUIPMENT



DIVISIONS OF AMERICAN MACHINE AND METALS, INC.: Troy Laundry Machinery • Riehle Testing Machines • De Balthazat Fans • Tolbert Centrifugals
Filtration Engineers • Filtration Fabrics • Niagara Filters • United States Gauge • Rehn Instruments • Lamb Electric Co. • Hunter Spring Co. • Glass-Stone Corp.

For an additional copy of this sketchbook Circle 442 on Page 19



RESERVED
FOR THE ENGINEER
CONCERNED WITH
DESIGNING SAFE,
DURABLE,
FLEXIBLE LINES

Send for your copy of
**"FACTS YOU SHOULD KNOW
 ABOUT SWIVEL JOINTS"**

CHIKSAN



A SUBSIDIARY OF FOOD MACHINERY AND CHEMICAL CORPORATION

Written by engineers and well illustrated, this file contains a wealth of useful information on the application of swivel joints in line design. You'll find facts and figures on torque, geometric characteristics, thrust and radial loads. There's information on how to approach design problems and a quick comparison between swivel joints and other flexible devices. And, you'll find a group of actual installation reports with diagrammatic drawings showing how the swivel joints were applied in the system. Be sure you have a copy of "Facts you should know about Swivel Joints" in your possession. Write Chiksan for your file today.

CHIKSAN COMPANY, 300 North Brea Blvd., Brea, California

Please send me a copy of "Facts you should know about Swivel Joints."

NAME _____

COMPANY _____

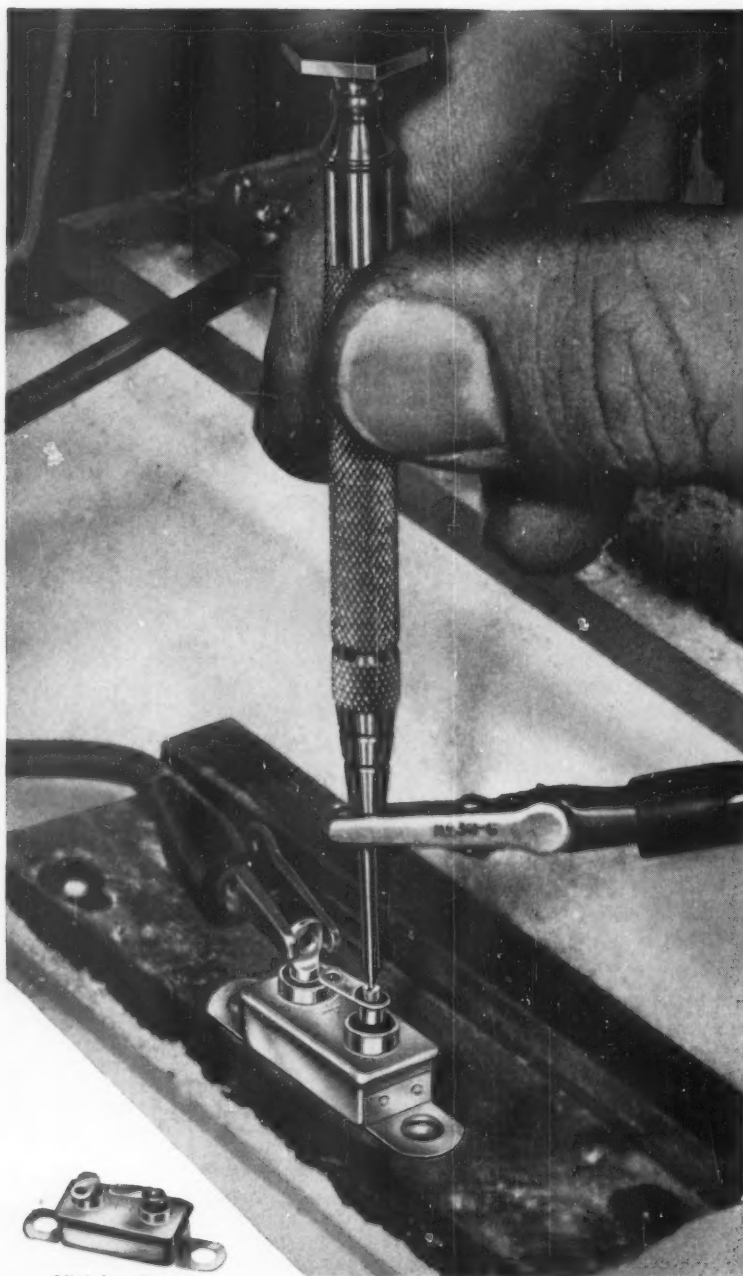
ADDRESS _____

CITY _____ STATE _____

#60-53

CHIKSAN COMPANY—Brea, California • Chicago 5, Ill. • Newark 2, N. J. • Divisions: Chiksan International, Hamer Valves, Weco • Subsidiary: Chiksan of Canada Ltd.

Tested To "Take It" on Missiles or Machines...



Miniature Sealed
THERMOSWITCH Unit
(actual size)

Another
example of how

Fenwal

CONTROLS TEMPERATURE...PRECISELY

The Fenwal Miniature Sealed THERMOSWITCH® Unit

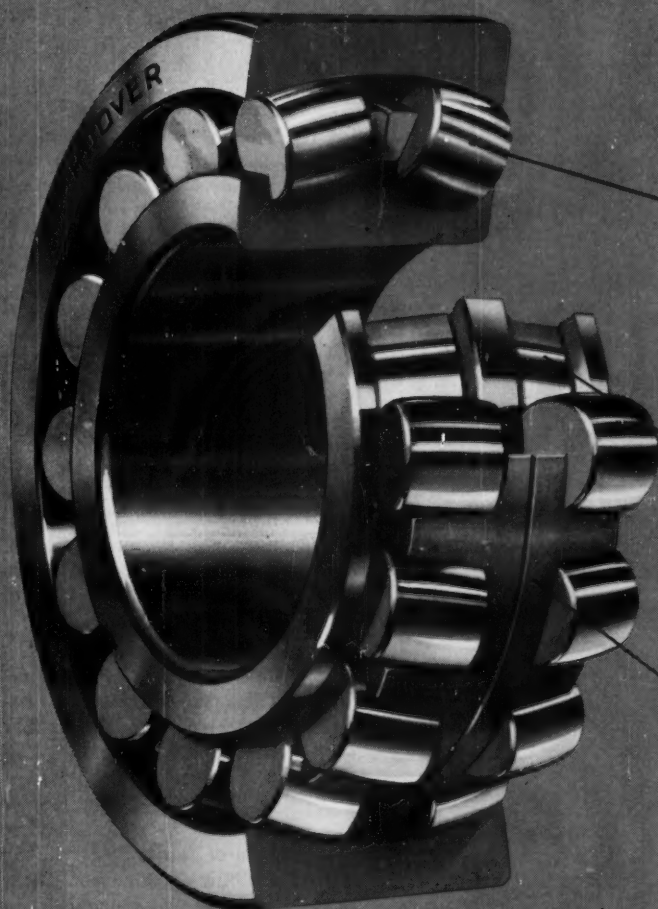
Here's the tiny temperature controller that's successfully handling some of today's toughest temperature control problems... in missiles and rockets as well as on production machines. Photo shows one of many quality control tests to insure product performance. *It's built to take a beating!*

Hermetically sealed, its rugged design permits normal control action even under the most severe conditions of shock and vibration. Stainless steel case is the heat-sensitive element... responds with instantaneous, positive action to heat changes of a fraction of a degree. Unit controls to extremely close limits. *Weights less than 1/4 oz.!*

Easily set for control of temperatures from -20 to $+200^{\circ}\text{F}$. When used as *high limit* switch, range is -20 to $+275^{\circ}\text{F}$. Can withstand continuous exposure from -65 to $+325^{\circ}\text{F}$. The Fenwal Miniature Sealed THERMOSWITCH Unit is widely used for crystal ovens, tuning forks, gyro assemblies, missile blankets, and missile batteries. Current rating: 2.5 amps, 115 VAC, 2.0 amps, 28 VDC. Find out how this advanced controller can protect the reliability of your product. Write Fenwal Incorporated, 197 Pleasant Street, Ashland, Mass.

hoover quality

...WHAT IT MEANS IN SPHERICAL ROLLER BEARINGS



**Super Finish
ROLLERS**

**Super Finish
RACEWAYS**

**MACHINED
BRONZE
RETAINERS**

In spherical roller bearings, *Hoover Quality* means extra smoothness, extra precision, extra bearing performance.

Large size rollers are *Super Finished* to a mirror-like smoothness to minimize friction.

Both inner and outer raceways are *Super Finished* to match the smoothness of the rollers. Precision matching of rollers and raceways assures

low operating temperatures and long life.

Land-riding retainers are accurately machined from solid bronze for proper roller guidance and uniform load distribution.

Hoover Quality spherical roller bearings are available in a complete range of sizes and series in cylindrical or tapered bore. Return the coupon below for complete information.

Hoover

BALL AND BEARING COMPANY

5400 South State Road, Ann Arbor, Michigan

Zone Sales | 8581 South Chicago, Chicago 17, Illinois
Offices and | 290 Ledl Street, Hackensack, New Jersey
Warehouses | 2020 South Figueroa, Los Angeles 7, California

Hoover Ball and Bearing Company
5400 South State Road, Ann Arbor, Michigan

MD-6

- ☐ Please send Bulletin 113 which describes Spherical Roller Bearings.
☐ Have your representative call.

Name

Title

Company

Address

City Zone State

THIS IS DU PONT DELRIN®



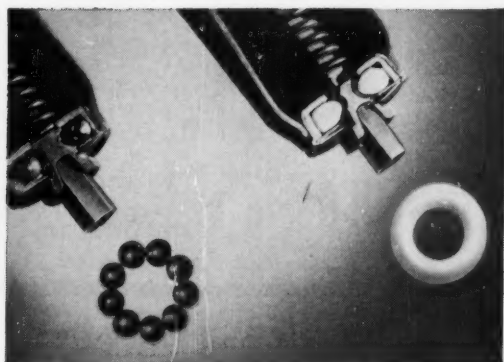
*a new engineering material
offering the user
distinct performance
and cost advantages
in many applications
once reserved for metal*

Today, in hundreds of products, "Delrin" acetal resin is being used where die-cast zinc and aluminum, cast and machined brass, stainless steel and cast iron were once considered "standard". For good reasons, too: in "Delrin", these products work better, cost less to make, or both. On the opposite page, you'll find three typical examples.

The performance advantages offered by "Delrin" are based on its unique combination of properties that frequently permits parts reductions through design of multi-function parts. "Delrin" has the stiffness to remain rigid in large sections, the tensile and flexural strength to withstand high-stress loadings, the dimensional stability to hold close tolerances and the frictional properties to operate usually without lubrication. And these properties are retained even under exposure to wide variations in temperature, humidity, solvents and stress.

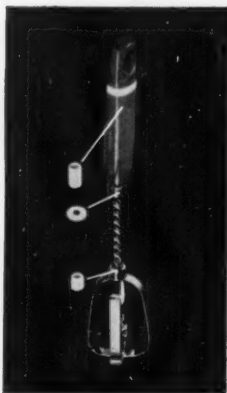
The cost advantages offered by "Delrin" stem primarily from its ease of fabrication, via injection molding or extrusion. These processes permit economical mass production. The need for finishing operations is usually eliminated. Part-to-part uniformity minimizes rejects. Assembly can be simplified by joining with mechanical fasteners, spin welding, snap or interference fits. "Delrin" is available in integral colors, and varied surface effects can be achieved by texturing, vacuum metalizing or painting.

We will welcome the opportunity to assist you in evaluating "Delrin" for your own product designs. A letter or the coupon at right will bring a prompt reply.

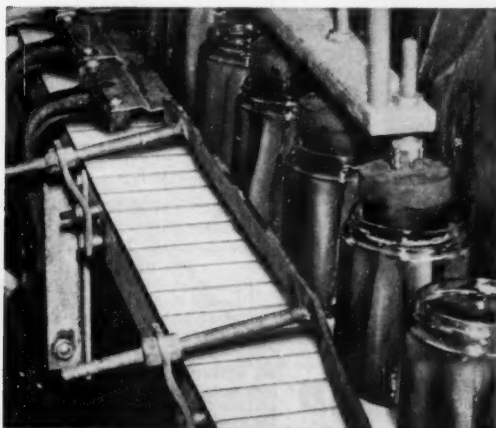


A ring of "Delrin" replaces nine steel balls in the bearings for roller conveyors produced by the Rapids-Standard Co., Inc., Grand Rapids, Mich. These new bearings offer the advantage of quiet operation. Beyond initial lubrication, no further lubrication is required. "Delrin" was specified because of its low coefficient of friction, high strength, corrosion resistance and dimensional stability. Bearings of "Delrin" are also featured in Rapistan® wheel conveyors. (Molded by Sinko Mfg. and Tool Co., Chicago.)

This one-hand egg beater features three parts of "Delrin" that replace a stamped brass bearing, a cold-rolled steel retainer and a brass bushing. The excellent frictional qualities of "Delrin" provide smoother, quieter operation. Tough and abrasion-resistant, "Delrin" provides a life span ten times longer than originally anticipated according to the manufacturer, Ekco Products Company, Chicago, Ill. (Molded by Vulcanized Rubber and Plastics Co., Morrisville, Pa.)



Flat-top conveyor chains of "Delrin" made by Fenco, Inc., Chicago, weigh only one-third as much as steel chains. Their service life is estimated at two to four times that of metal conveyors. Initial cost is 40-50% lower and little maintenance is required. The flat links of "Delrin" are strong, resistant to abrasion and corrosion, have a low coefficient of friction, require no lubrication. (Molded by Du Bois Plastics Product Company, Buffalo, N. Y.)



THIS IS WHAT DELTRIN® IS DOING

Now that "Delrin" acetal resin is available commercially, a rapidly increasing number of applications are going into commercial production: gears, bearings, housings, valve parts, plumbing fixtures, sporting equipment, telephone components, household items, clothing fitments, and many others.

During the past three years, over 500 applications of "Delrin" were field-tested by some 250 manufacturing concerns. The success of these wide-ranging tests suggests that "Delrin" may well help you, too, improve a product, lower its costs, or develop new designs for your profit. Commercial processors, and our own staff of technologists will gladly provide you with more information.

POLYCHEMICALS DEPARTMENT



REG. U. S. PAT. OFF.

Better Things for Better Living . . . through Chemistry

FOR MORE SPECIFIC INFORMATION MAIL THIS COUPON

E. I. du Pont de Nemours & Co. (Inc.)
Department V-623, Rm. 2507D
Nemours Building, Wilmington 98, Delaware

I am interested in evaluating "Delrin" for the following use:

NAME _____
COMPANY _____ POSITION _____
STREET _____
CITY _____ STATE _____

In Canada: Du Pont of Canada Ltd., P. O. Box 660, Montreal, Que.

add this new twist
to your profit picture



NO FLARING
NO THREADING
NO SOLDERING
NO WELDING



assembled anywhere--
with just a wrench
and lubricant

WEATHERHEAD ERMETO STEEL FITTINGS

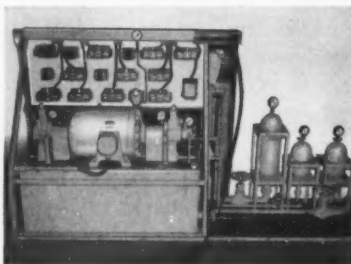
ERMETO Ease of Assembly Saved These Companies TIME and MONEY

Weatherhead Ermeto flareless hydraulic fittings—easily assembled by inexperienced personnel without elaborate tools—are enabling many companies to achieve important installation savings in both time and money. In service, the excellent leak-proof, anti-vibration characteristics of Ermeto fittings keep maintenance and down-time at a minimum. Ermeto fittings are available in stainless or carbon steel with "Weathercote" or cadmium finish. All shapes in sizes: $\frac{1}{8}$ to 2", for pressures up to 10,000 psi.



SAVED: \$5,000

COMPANY: Good Roads Machinery Corporation
Minerva, Ohio.
APPLICATION: Carbon Steel Ermeto fittings on hydraulically-actuated snow plows on industrial tractors. Operated with hydraulic oil at 100° F and 400 psi.
RESULTS: Ermeto fittings saved the company \$5,000 because of their ease of assembly and because experienced help was not necessary.



SAVED: 60 HOURS

COMPANY: Portland Industries
South Portland, Maine
APPLICATION: Carbon Steel Ermeto fittings on automatic transfer machine for making carburetor bodies. Operated with hydraulic oil at 120° F and 800 psi.
RESULTS: Utilization of Ermeto fittings saved the company 60 hours in installation time—thanks to the ease and simplicity of assembly.

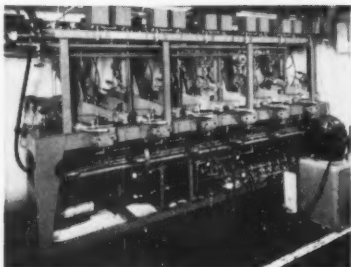
WEATHERHEAD BULK HOSE AND HOSE ASSEMBLIES

BULK HOSE
Twenty different styles available. From $\frac{1}{4}$ " to 2" O.D. for working pressures up to 10,000 psi.

HOSE ASSEMBLIES
Completely fabricated with permanently attached swaged ends. Any size, any quantity for working pressures up to 10,000 psi.



Write for new general catalog—contains complete data and specifications for all items.



SAVED: 40 HOURS or \$240

COMPANY: Emhart Manufacturing Company
Hartford, Conn.
APPLICATION: Carbon Steel Ermeto fittings on pressure forming machine for small parts manufacture. Operated with hydraulic oil at 130° F and 1500 psi.
RESULTS: Ermeto fittings provided an estimated savings of 40 hours or \$240 in installation time. Ermeto fittings were used specifically because of their ease of assembly.

BRASS & STEEL FITTINGS
HOSE & ASSEMBLIES
TOOLS & ACCESSORIES



WEATHERHEAD

FOR DETAILS

See Weatherhead catalog in Sweet's Product Design File, Plant Engineering File, the Fluid Power Directory, or write direct.



THE WEATHERHEAD CO., FORT WAYNE DIVISION
Dept. MD6, 128 W. Washington Blvd., Fort Wayne, Ind.
In Canada:
The Weatherhead Co., Ltd., St. Thomas, Ont.



R/M engineers helped marine transmission manufacturers solve clutch problems for this 55-ft. Chris-Craft Constellation. Twin engines develop up to 550 hp, provide speeds to 23 mph; equipped with newly designed hydraulic aluminum marine transmissions with R/M sintered bronze clutch material.

Photo courtesy Chris-Craft

How Raybestos-Manhattan helped design clutch for new marine transmission

"The extensive friction material knowledge and experience of R/M engineers save us time and money when we are working on a new design for a clutch or friction part," says Carl Benson, assistant manager and chief engineer, Paragon Gear Works, Taunton, Mass.

Solve problems on spot

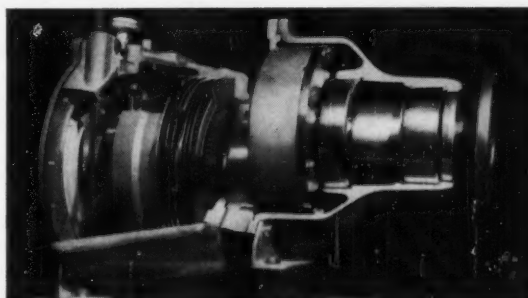
"In developing our new 'H-A' hydraulic aluminum transmission, we took an R/M engineer right with us to our customer's engine plant in Michigan. We solved our clutch problems on the spot.

"Our customers appreciate this extra engineering service we can offer them through R/M. Wherever we are we know we can pick up the phone and have the nearest R/M engineer come to us. We get this extra service, yet prices are competitive; quality is uniformly high."

Save time, money

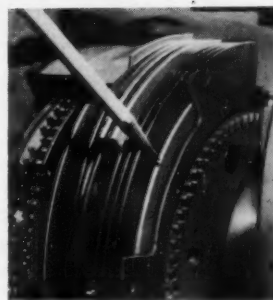
You may also be able to save time and money by calling on experienced R/M engineers to help solve your friction problems. You can depend on sound, unbiased counsel on the material best suited for your application—for only R/M manufactures all types of friction materials! An R/M sales engineer can be at your desk within 24 hours.

Send now for your free copy of Bulletin No. 501—packed with helpful engineering information on friction materials.



Advanced-design Paragon "H-A" hydraulic aluminum transmission for Chris-Craft 430 engine which develops 275 hp at 4000 rpm. Clutch is self-compensating; no adjustment ever.

Pencil points to R/M sintered metal clutch facing. .015 in. of sintered bronze on .070 in. steel plate. Has a high coefficient of friction in presence of oil; strength to withstand 4000 rpm; precision operation within narrow clearances of .007 to .010 in.



RAYBESTOS-MANHATTAN, INC.

EQUIPMENT SALES DIVISION: Bridgeport, Conn. • Chicago 31 • Cleveland 16 • Detroit 2 • Los Angeles 58



TO THE ENGINEER

who can't tolerate a lapse of memory

If you're working on a think machine that can't afford to break its train of thought, consider AE's pint-size, fast-stepping OCS switcher. Unlike electron tubes and relays, this sophisticated device won't lose stored memory in the event of power failure or circuit interruption.

Besides, it can do the work normally assigned to whole banks of relays.

The AE Series OCS will follow or initiate a prescribed series of events or cycles at 30 steps per second impulse-controlled, or 65 steps per second self-interrupted. Any programming sequence can be set up on one to six cams with as many as 36 on-and-off steps

per cam. And each cam will actuate as many as six contact springs.

In any event, if your designs involve relays or stepping switches, AE circuit engineers may be able to save you a pretty penny. Or, if you'd like to leave the switching to us, we're equipped to supply prewired and assembled, custom-built control units, or help you develop complete control systems.

To explore the matter, just write the Director, Control Equipment Sales, Automatic Electric, Northlake, Illinois. Also ask for Circular 1698-H: *Rotary Stepping Switches*; Circular 1702-E: *Relays for Industry*; and our new 32-page booklet on *Basic Circuits*.

**AE
CAN
DO**



AUTOMATIC ELECTRIC

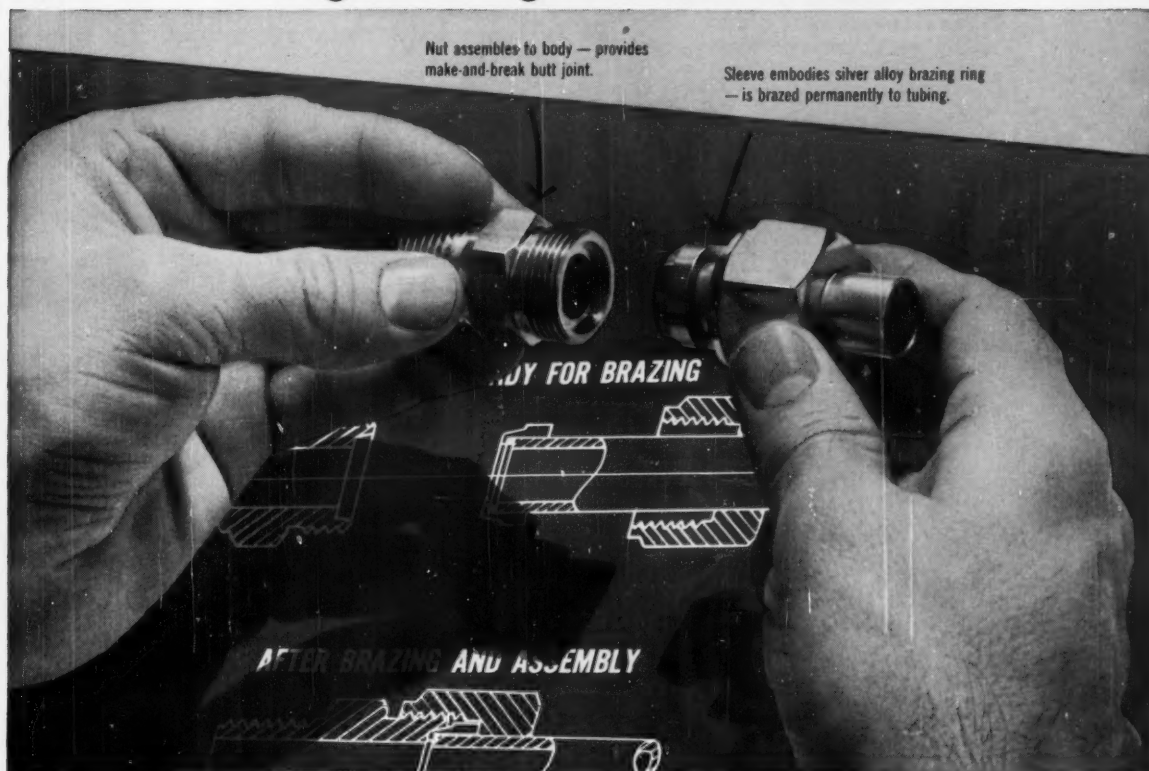
Subsidiary of

GENERAL TELEPHONE & ELECTRONICS





IMPERIAL *Engineering and Data File*



NEW BRAZE-SEAL FITTING

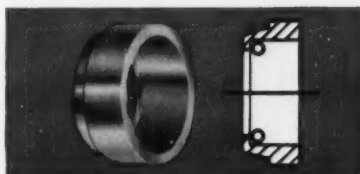
WITHSTANDS SUPER-PRESSURES, HIGH TEMPERATURES ... RETAINS MAKE-AND-BREAK CONVENIENCE

Until Imperial Braze-Seal came along, engineers could not specify an economical make-and-break fitting for tubing circuits involving super-pressures and high temperatures. Applications like these called for welded connections. But now Braze-Seal offers high reliability, even under extreme pressures. (See chart below.)

MAXIMUM DESIGN PRESSURES (PSI) FOR BRAZE-SEAL FITTINGS

Tube O.D.	316 Stainless	Carbon Steel
3/8"	64,000	48,000
1/2"	62,400	46,800
9/16"	61,600	
5/8"	61,600	46,200
3/4"	60,000	45,000
7/8"	56,000	42,000
1"	52,000	39,000
1-1/4"	48,000	36,000
1-1/2"	44,000	33,000

Factor of safety should be selected by design engineer commensurate with application and the specified tubing.



This Braze-Seal Sleeve, containing a silver alloy brazing ring, is the key to the performance of the Braze-Seal Fitting. It assures a joint that will withstand these extreme pressures because it is permanently brazed to tubing. Yet the fitting provides the convenience of a make-and-break butt joint, as illustrated, and is extremely easy to assemble.

Reducing Sleeves Provide Versatility

Can be furnished to reduce any size Braze-Seal tube end to any specified tube size. Extremely convenient on tees, for example, where any size tubing can be connected to the same tee body.

Also, the same body may be used for making up flareless Hi-Seal fitting joints.

Imperial Braze-Seal Tube Fittings can be furnished in steel or stainless steel.

Check the outstanding features of Braze-Seal for yourself. Send for a sample fitting. See how Braze-Seal can help you solve the most difficult problems in super-pressure and high-temperature tube circuitry.

IT'S IN THE BOOK

Braze-Seal Fittings are covered in Imperial's new Hi-Seal Catalog — the most comprehensive coverage available on the subject of fittings, a hard-working handbook for engineers. Send for your copy today.



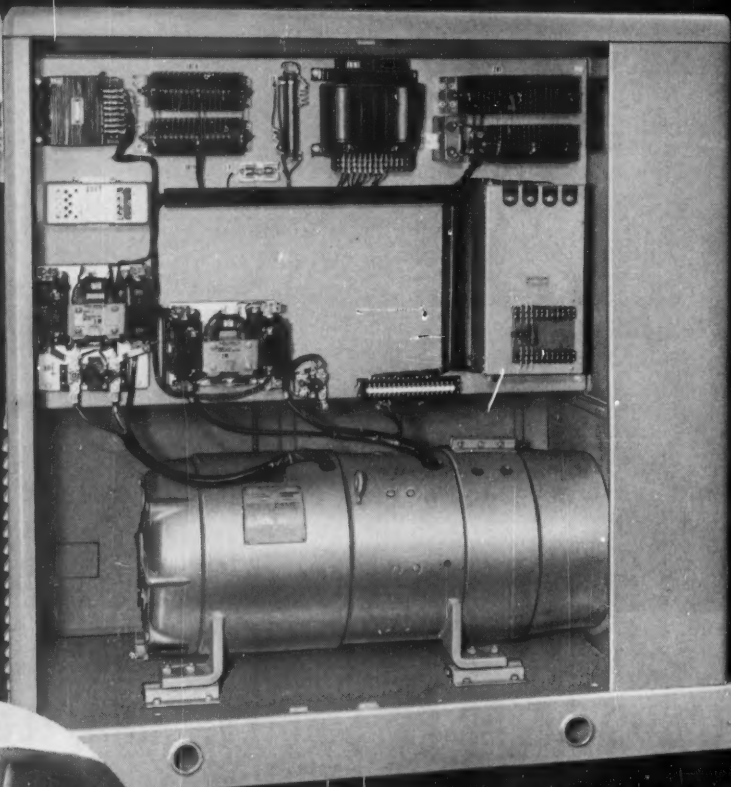
THE IMPERIAL BRASS MANUFACTURING CO.

Dept. MD-60, 6300 West Howard Street
Chicago 48, Illinois

8-60

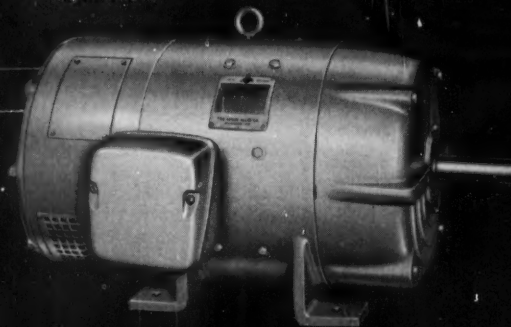
"BUILDING-BLOCK" FLEXIBILITY permits adding and removing of circuits in your plant by your own electrician. The 6" x 6" transistor control panels have exceptionally high resistance to heat, moisture, and electrical breakdown.

FINGERTIP OPERATOR CONTROL with start and stop pushbuttons and potentiometer speed setting dial. Small potentiometers greatly reduce size of operator's control panels and are dust-tight for maximum protection.



DEPENDABLE TRANSISTORS are heavy-duty industrial components rated 35 volts, but stressed to only half their nominal rating in our circuits. They have unusually high gain with twice the speed of response and only half the drift in gain of tubes. Transistors never fade — normally provide 15 or more years of dependable service.

RUGGED FLEXITORQ motors offer very high commutating ability; 400% short-time and 15% continuous overload capacities; fast acceleration and deceleration. Made in various enclosures, these compact motors permit external mounting of gear heads, blowers, tachometer generators, etc., to meet any operating requirement.



It's ideal for single-motor and
synchronized multi-motor drives for:

Extruders
Wire-drawing machinery
Machine tools
Conveyors
Calenders
Paper machinery
Textile machinery
Printing presses
Test stands
Adjustable frequency
power supplies
and many other applications

Another NEW product from Louis Allis

The New LOUIS ALLIS Select-A-Spede® Drive —First with field-proved All-Transistor Control

**a high-gain, high-performance d-c drive with unmatched
flexibility and low upkeep**

Here's a superior adjustable speed drive with simplified transistor-magnetic amplifier control. It's the easiest drive to set up and operate. A twist of the dial gives you stepless speed adjustment from zero to full speed in either direction. Each adjustment is independent, thus sparing you the need for compensating adjustments of inter-related settings. You get more consistent day to day operation because transistors — *unlike tubes* — are highly dependable.

The new Select-A-Spede defies obsolescence. To add functions, such as current limit, to your basic drive, you simply have your electrician install the "current limit" transistor circuit panel. These "building-block" panels allow you to add any of the 13 control circuits that changing conditions call for — and they are immediately available from Louis Allis stock. Thus a rebuilding or adaptation job that, on former equipment, cost thousands of dollars — excluding down-time — can now be done at a fraction of the cost and time *right in your own plant!*

Transistor control practically eliminates upkeep and down-time. High quality transistors, field proven in missiles and other advanced electronic equipment, assure you of a high degree of dependability with a life expectancy of 15 or more years. Printed low-voltage transistor circuits are virtually trouble-free and can be quickly and easily replaced from low-cost stock.

Further savings are provided by the new Louis Allis Flexitorq® drive motors through vastly improved commutation, low brush wear, and their ability to safely withstand momentary overloads of 400% of normal horsepower rating.

If you want superior speed regulation on your drive, check the new Louis Allis Select-A-Spede with *all-transistor* control. Sizes from 5 to 400 hp — in a wide range of enclosures and speed ranges up to 20:1. Contact any one of the 60 Louis Allis District Offices for information and application assistance. Or write for bulletin 2001 to The Louis Allis Co., 459 E. Stewart St., Milwaukee 1, Wisconsin.

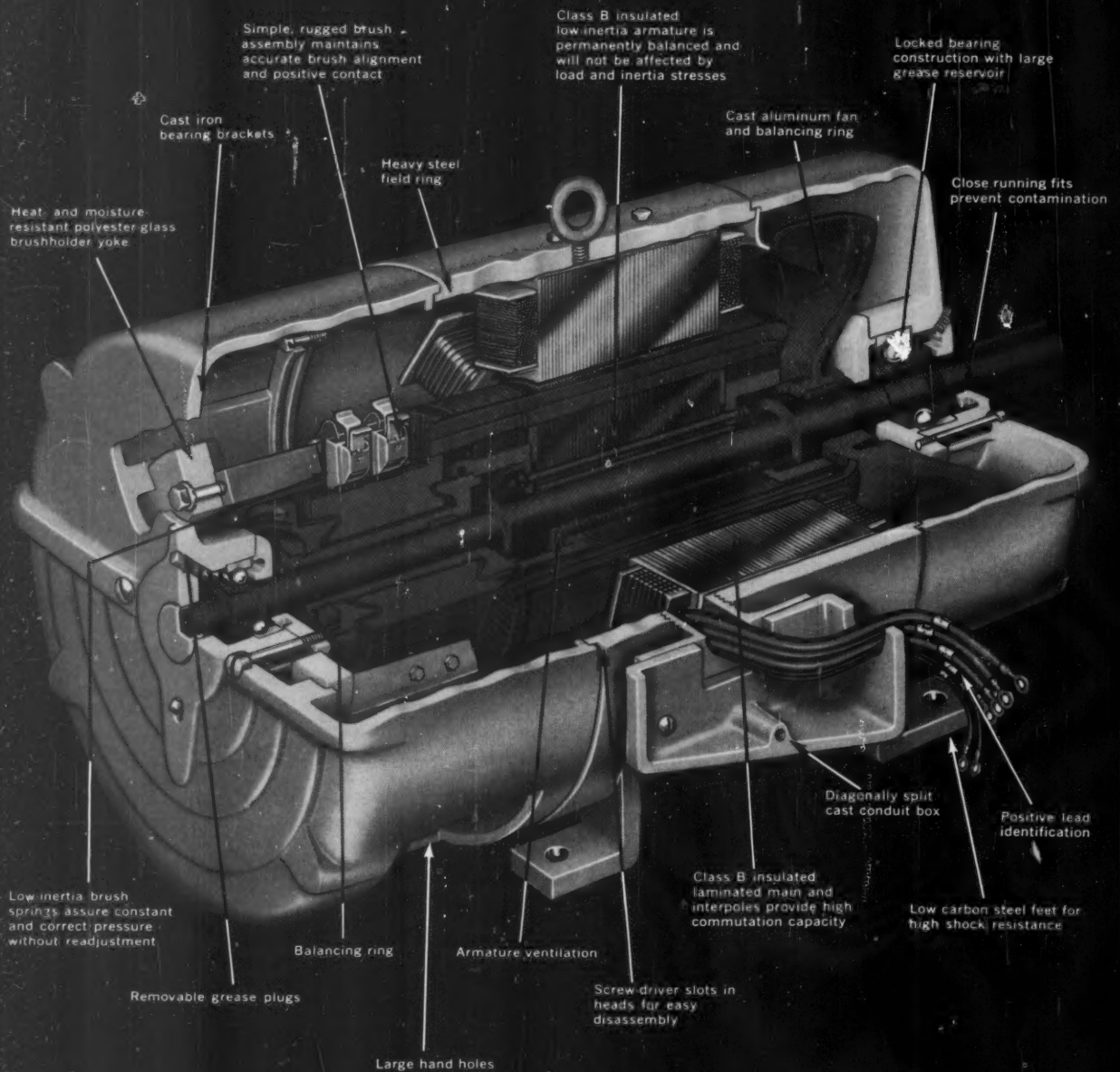


MANUFACTURER OF ELECTRIC MOTORS AND ADJUSTABLE SPEED DRIVES

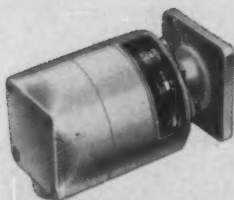
LOUIS ALLIS

Circle 451 on Page 19

Here's the latest in D-C motor design:



...and some
easy-to-add
field modifications



A-c tachometer for speed indication

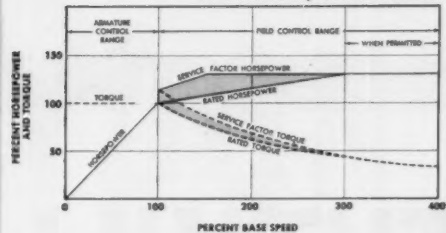


A-c motor-driven blower with permanent dry-type filter for easy mounting on bearing bracket



Magnetic disc-type brake with d-c series or shunt, or a-c coils

**FLEXITORQ sets new standards for
d-c motor performance**



LOUIS ALLIS FLEXITORQ MOTORS

- are rated 60° C rise for continuous operation
- provide 1.15 service factor operating at base speed, and 1.30 service factor at 150% to 300% speed
- may be operated from 300% to 400% of base speed at 130% load with 1.0 service factor, where size permits
- short-time overloads of 400% can be commutated at base speed and below

Another new product from Louis Allis

New Louis Allis FLEXITORQ® D-C MOTORS

**...offer you vastly improved commutation—
low brush wear—400% short-time overload capacity—
and unmatched flexibility!**

Bear this in mind: The Flexitorq is *not* just another *re-rated* d-c motor. It's *all-new* — and it's been designed to give you more for your power dollar — in superior performance, matchless field flexibility, and unrivalled economy of operation and upkeep.

Advanced armature design and brush construction offers improved commutation, faster response, and lower brush wear. Class B insulation system provides exceptional thermal endurance . . . is rated for 60° C rise for continuous duty . . . and creates a barrier to moisture, acids, alkalis, and other abrasive and corrosive contamination.

The net result to you is reliable, trouble-free power for constant and adjustable speed drives. For example, Flexitorq gives you 400% faster acceleration, plus much better deceleration, reversing, and speed changing. You can safely impose 400% intermittent and 15% continuous overloads — and the high-torque design is a welcome plus when you need extra power for hard-to-start machines.

The new Louis Allis Flexitorq is lighter and more compact than previous d-c motors . . . lets you squeeze more power into less space . . . yet is actually *easier* to service! Brushes and entire brush-holder assemblies can be quickly inspected and removed without major disassembly. And since brush springs remain conveniently attached to the brush holders, brush changing is a simple affair.

Flexitorq d-c motors are available in sizes from 1 to 400 hp — in various enclosures. See your nearby Louis Allis District Office for information and application help. Or write for Bulletins 3150 and 3200 to The Louis Allis Co., 459 E. Stewart Street, Milwaukee 1, Wisconsin.



Helical single, double, and triple reduction gear units for all ratios



MANUFACTURER OF ELECTRIC MOTORS AND ADJUSTABLE SPEED DRIVES

LOUIS ALLIS

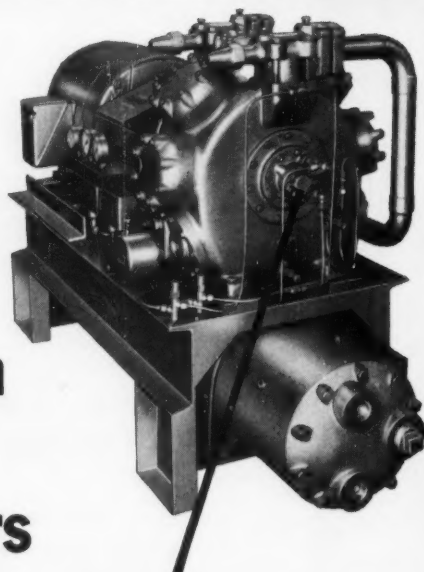
DC-216

Circle 452 on Page 19

Another pump problem . . . solved by **TUTHILL**

TUTHILL PUMPS

For Positive Lubrication of New Brunner Multi-Drive Compressors



The new Multi-Drive refrigerating compressors recently announced by the Brunner division of Dunham-Bush have been "engineered to insure extreme dependability, greater flexibility, maximum performance characteristics, and highest quality".

With these objectives naturally Brunner selected Tuthill lubrication pumps as an integral part of the forced feed lubricating system. Based on their long experience in working together, Brunner knew that Tuthill's engineers would propose a reliable unit which could be incorporated in their new equipment with the greatest possible ease . . . and would most closely meet the performance characteristics demanded by the application.

Special features

The Tuthill units finally developed reflects Tuthill's proven ability to "Fit the pump to the problem". These are modifications of Tuthill's model RLV, provided in two different sizes to cover the complete range of compressors. They have Tuthill's special reversing feature . . . required in this instance since the compressors are designed to run in either direction. At the customers request, they are provided with relief valves and a specially modified shaft extension.

And a complete new housing was designed to incorporate the unit directly into the compressor for

greatest possible ease of assembly and most attractive appearance.

Over 800 models

Hundreds of industrial leaders like Dunham-Bush have learned the advantages of bringing their pump problems to Tuthill. For Tuthill offers a complete selection of over 800 standard models . . . plus extensive engineering skills and experience in adapting these standard pumps to fit the requirements of special applications. Their reliability has been proven by thousands of demanding applications including lubrication, coolant hydraulic, oil burning, circulating . . . the list could go on and on.

Catalog 100 gives an overall view of Tuthill's comprehensive line. Write for your copy today . . . or better yet forward details on your application for our engineering proposal.

Tuthill manufactures a complete line of positive displacement rotary pumps in capacities from 1 to 200 GPM; for pressures to 1500 PSI; speeds to 3600 RPM.



TUTHILL PUMP COMPANY

953 East 95th Street, Chicago 19, Illinois



MACHINE DESIGN

HAYDON

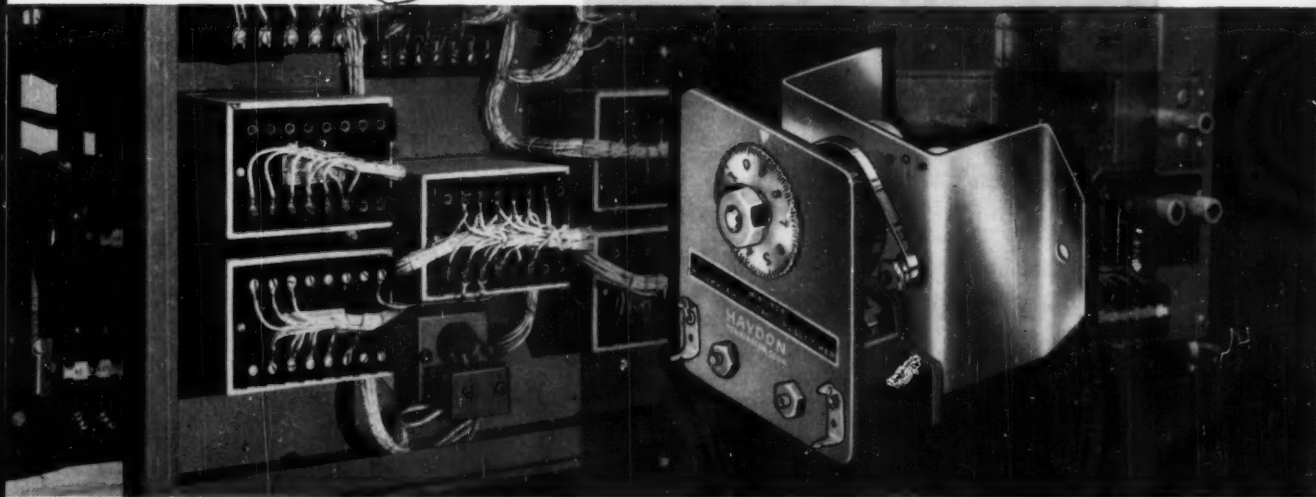
Timing Devices

help insure dependable operation
of RELIANCE "V★S" DRIVES



Famous Reliance "V★S" (Variable Speed) Drives are used in the nation's leading steel, paper, and chemical plants . . . and in hundreds of other industrial applications where failure of the drive unit would cause the loss of thousands of dollars in work spoilage and downtime. Because dependable performance is a primary requirement for all components, Reliance uses Haydon Time Delay Timers in its V★S Drives to protect vital thyatron tubes by delaying flow of electricity to the tubes for a precisely timed interval. This allows the cathode to reach correct operating temperature, and protects against tube failure during the first few minutes of operation.

Timing performance like this is available for your applications. For additional information on Haydon Timing Motors and Devices, write for our General Catalog.



Meeting Special Requirements with Standard Units...
The Haydon Timing Devices used on Reliance V★S Drives are standard DA-21 Time Delay Timers . . . with special modifications developed by our expert application engineers. In this way, individual timing needs are met exactly . . . without incurring the cost of custom timers.

*Division of
General Time Corporation*

Haydon
AT TORRINGTON

3130 EAST ELM STREET, TORRINGTON, CONNECTICUT

Circle 454 on Page 19



WANTED

a real
PRECISION motor
twenty five millionths
(.000025) vibration
amplitude
maximum shaft runout—
75 millionths (.000075)

Now it's here . . .

THE POPE PRECISION MOTOR

Totally Enclosed
Fan Cooled
Custom-Built

1 to 20 H.P.—900 to 3600 R.P.M.—with straight or tapered shafts

Here is a Precision Driving Motor that has the rigidity and dynamic balance you've always wanted!

The permanently preloaded double row cylindrical roller bearings with tapered bores are mounted in a heavy section one-piece casting. (There is no front end cover to get out of alignment.)

A pair of extra large precision angular contact preloaded bearings in the rear housing are mounted close to the rotor for extra rigid support of the motor under working loads.

You can make fast convenient wiring connections from the large junction box furnished on whichever side of the motor you specify.

Ask for data sheet SK-306 for outline dimensions and specifications.

Let us quote you on these Precision Driving Motors for use on all your equipment where a real Precision Motor is required.



One of the new Pope Precision Motors equipped with a Pope balancing type wheel holder for precision grinding.

No. 130

POPE®

ENGINEERS, DESIGNS AND BUILDS
PRECISION ANTI-FRICTION BEARING SPINDLES
FOR EVERY PURPOSE

POPE MACHINERY CORPORATION • 261 RIVER STREET • HAVERHILL, MASS.

Established 1920

From **HANNIFIN**...
unit construction
to give you air valves
that do more jobs



Hannifin 3/4" four-way valve with "universal" base and new Speed Control section. Single-solenoid actuated, 10 other actuators available.



Hannifin's exclusive "spool-poppet" seals bubble-tight at either end of its short stroke.



For complete I.C. compliance, valve is electrically inoperative until dust-tight, splashproof solenoid cover is replaced and fastened tightly. Result: no more clogged, jammed solenoids.

One of the versatile—and most popular—Hannifin air control valves is this "CC" series, single-solenoid model. It is available for either 1/4" or 3/8" air lines and is gasket-mounted to its own base. This particular base (one of three choices offered) can either be O-ring gasketed to your manifold or mounted over an opening in your bracket or machine. It will receive all four lines from below or take the inlet line from below and the two cylinder lines out one side. Or, you can make all connections at the sides.

When it comes to actuation, Hannifin offers an even wider selection: hand, foot, cam, pressure, single or double solenoid.

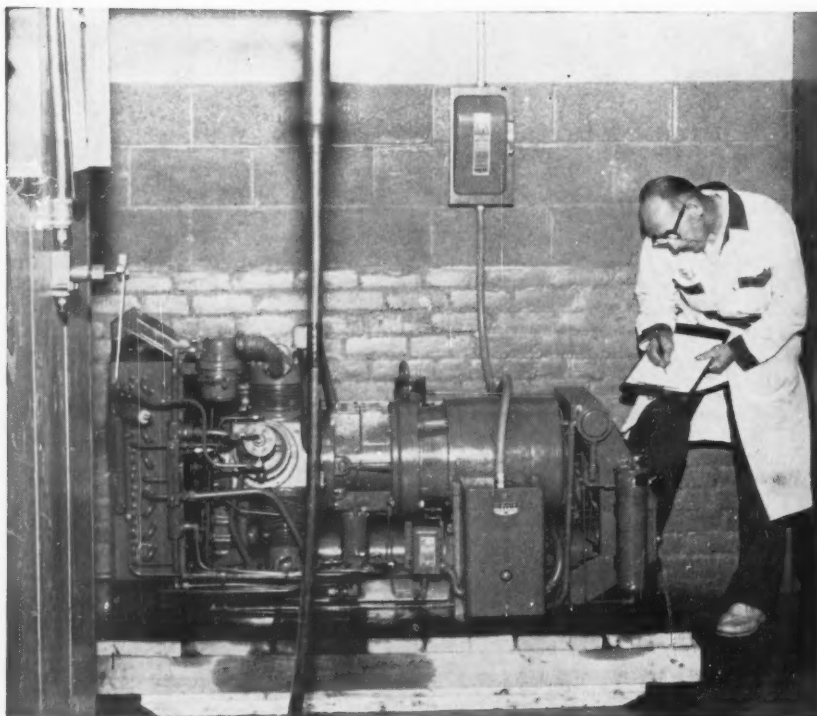
When necessary, you can remove this entire valve from its base without disconnecting air lines. Or, the exclusive "spool-poppet" can be replaced without even breaking electrical connections.

The "CC" series, like all Hannifin valves, is designed with "full flow" internal passages as large or larger than its rated pipe size.

You will find these and most other Hannifin valves described in Hannifin's new "Valve Finder." Get your copy from your Hannifin man, listed in the A-Z volume of Thomas' Register, or write:

HANNIFIN COMPANY

525 South Wolf Road • Des Plaines, Illinois



This compact compressor supplies 15 CFM at 3500 psi in a high pressure hose testing facility. Similar machines are available for pressures up to 5000 psi, and volumes up to 80 CFM.

A COMPACT COMPRESSOR FOR HIGH PRESSURE AIR—UP TO 5000 PSI

Joy High Pressure Compressors are easily portable, highly reliable sources for high pressure air for testing. Originally developed for military jet aircraft and guided missile programs, Joy compressors in pressure ranges up to 5000 psi are field proven for reliability and durability. Currently, they are being used to test high pressure equipment, such as hose, valves, and fittings in numerous Research and Development installations.

These high pressure compressors are compact, multi-stage, V-type machines which are designed for continuous operation. They can be supplied for either electric or gasoline motor drive, and can be skid-mounted or equipped with wheels for complete portability.

If you have testing facilities which require extremely high pressure air, it will pay you to get complete details about the Joy machines. Write for Bulletin 1014-64B.



AIR MOVING EQUIPMENT FOR ALL INDUSTRY



Dust Collectors



Reciprocating & Dynamic Compressors



Fans and Blowers

JOY

Joy Manufacturing Company
Oliver Building, Pittsburgh 22, Pa.

In Canada: Joy Manufacturing Company
(Canada) Limited, Galt, Ontario

GENERAL  ELECTRIC

Developed Exclusively for Tri-Clad* '55 Motors

NEW THERMO-TECTOR SYSTEM POSITIVELY

ELIMINATES OVERLOAD BURNOUT

Allows Maximum Motor Output -- Safely!

Now Tri-Clad '55 motors have simple, direct-acting thermal protectors that *positively* end winding failures from overloads!

New Thermo-Tector heat-sensing switches buried in stator windings react *instantly* to prevent heat damage. Unique Thermo-Tector "anticipation" feature varies motor shutoff point according to rate of winding heat rise. This ends need for operating safety margin.

Thermo-Tector system uses no costly amplifying relays or special circuitry, works with any General Electric motor controller.

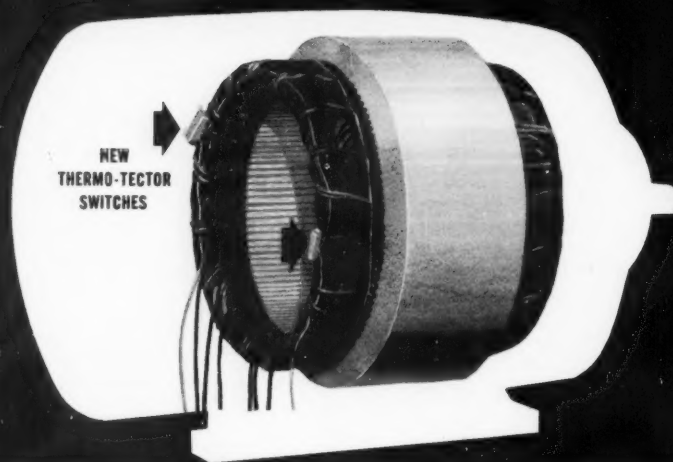
*Registered Trade mark of General Electric Co.

TURN PAGE FOR FURTHER INFORMATION

NOW!

**GET MAXIMUM
MOTOR OUTPUT
WITH NO DANGER
OF OVERLOAD
BURNOUT!**

New THERMO-TECTOR System
Operates IN THE STATOR . . .
Protects Under All Conditions!



You get *full output* from Tri-Clad '55' motors with Thermo-Tector protection. No operating "safety margin" is necessary since Thermo-Tector switches react instantly to prevent damage from *any* type of winding overload. New General Electric Thermo-Tector switches—buried deeply in the coils of the Tri-Clad '55' motor—are so durable they handle size 4 contactor coil current with *no costly amplifying relays*. Any conventional G-E motor controller works with the Thermo-Tector system.

Thermo-Tector protection is available on *all* Tri-Clad '55' motors in frames 254U-445U. For more information, contact your G-E Apparatus Sales Office or write for Bulletin GEA-7092, Section 866-2, Schenectady 5, N. Y.

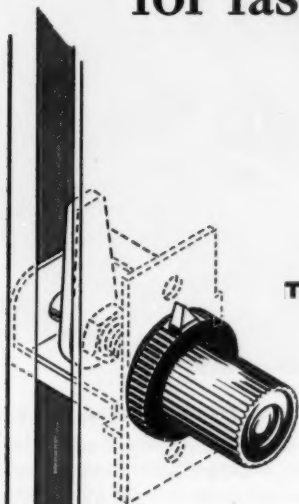
SMALL AC MOTOR & GENERATOR DEPARTMENT

GENERAL  ELECTRIC

Circle 458 on Page 19

Standards with unique features for fastening doors and panels

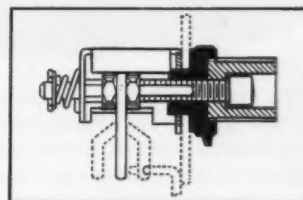
Southco adjustable pawl fasteners are easy and economical to install, give a "class" appearance to equipment. They apply controlled pressure to seal tightly and stop rattles.



TWIN KNOB CONTROL—NO. 46

The pawl engages the frame when the actuator is turned 90°. A bright chrome button in the center of the knob is preset for the amount of pressure to be exerted by the fastener. After the pawl engages the frame, the knob is turned until the button is flush with the knob surface. Preset pressure is thus obtained.

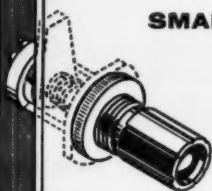
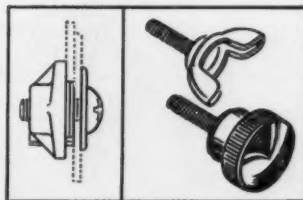
Materials *Body: Cadmium plated steel*
Knob: Black nylon



MINIATURE ENVELOPE—NO. 45

Requiring a minimum of space inside and outside, this fastener latches on a 1/4 turn and additional turning pulls up the door or panel against its frame. The nylon pawl operates smoothly against metal and provides exceptional wearing qualities.

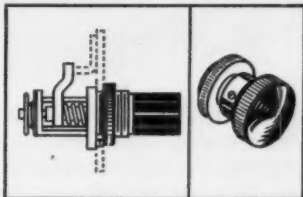
Materials *Pawl stop and washers: Carbon steel, cadmium plated*
Pawl: Nylon, natural



SMALL, HEAVY-DUTY MOUNTING—NO. 48

Small, rugged, compact. One quarter turn closes, additional turning tightens. Quickly installed with a single mounting nut. Three sizes cover every frame thickness from .000 to .750. Can be supplied with flattened shaft for your knob.

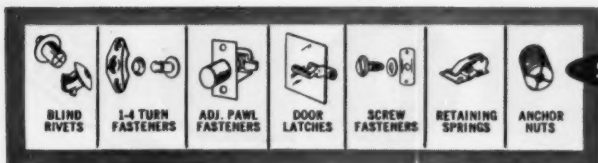
Materials *Body and pawl: Steel, cadmium plated*
Knob: Black nylon



© 1960

FREE!

Your copy of Southco Fastener Handbook containing engineering data on wide selection of fasteners. Write to Southco Division, South Chester Corporation, 237 Industrial Highway, Lester, Pa.



SOUTHCO

FASTENERS

LION



EVOLUTION OF



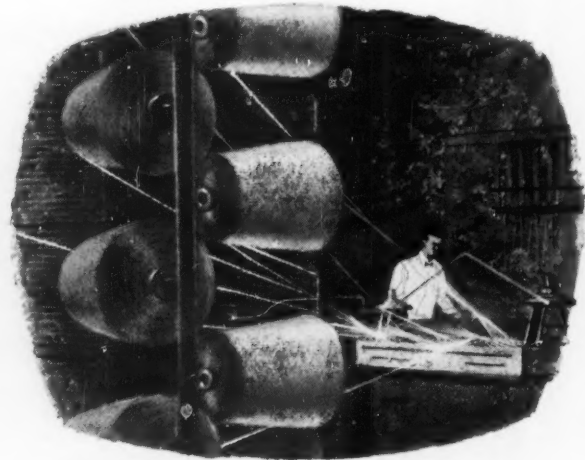
IT ALL STARTED when Leonardo da Vinci invented the belt drive for his polishing wheel. Spurred on by the drive's many advantages, engineers have striven for a more effective method of indirect power transmission ever since.



THE NEXT MAJOR DEVELOPMENT, although then seemingly unrelated, was the discovery of the vulcanization of rubber in 1839. Charles Goodyear not only fathered a multibillion-dollar industry, but also helped pave the way to much more efficient power transmission.



ANOTHER MAJOR BREAKTHROUGH came in 1941, when Goodyear introduced the first practical Steel Cable V-Belt for use on Army tanks. Here was the strongest, most efficient, most heat- and stretch-resistant belt ever built. A wartime success, steel cable is used in belts handling today's toughest industrial drives.



THEN CAME THE "MIRACLE" FIBERS and super-rated V-belts. Again Goodyear was in the fore with the HY-T V-Belt—a strong, shock-resistant belt that answered most multiple drive problems. But V-belt makers still sought a more effective way to overcome stretch and shrinkage.

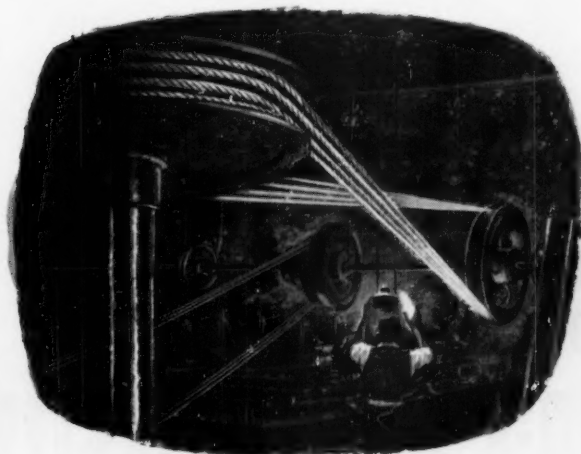
For maximum, trouble-free horsepower hours on any V-belt drive, insist on the top belt from the top beltmaker.

Lots of good things
come from

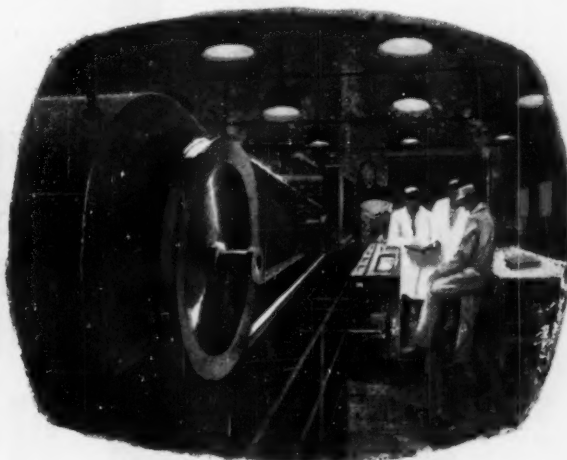
GOOD



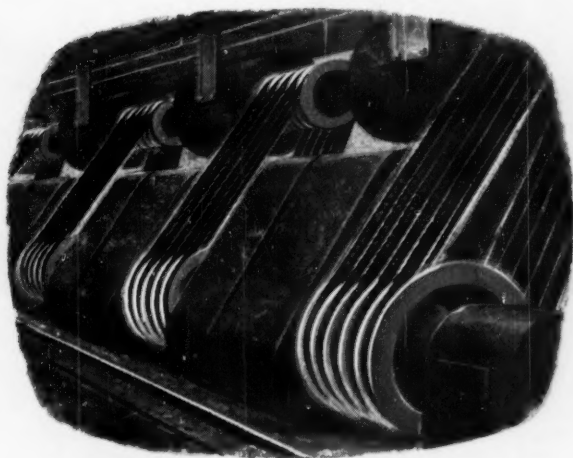
A REVOLUTION



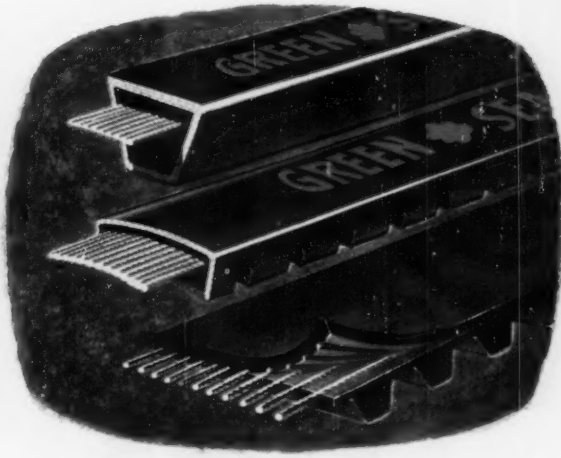
OVER A DECADE PASSED BEFORE a man named Combe introduced two new ideas in the transmission of power—teams of load-carriers and “wedge-in” action. His first multiple rope drive was not very efficient or durable, but started a whole new trend in development.



IT TOOK A LITTLE TIME before the first rubberized V-belts were introduced. Many of the earliest improvements were developed by Goodyear scientists. The greater efficiency of the V-belt soon placed it on many drives, despite shortcomings in length stability and strength.



GOODYEAR SOLVED THE PROBLEM with the 3-T Process to take surplus shrinkage and stretch out of synthetic cord. That development made possible multiple drive V-belts with true dimensional stability—Green Seal V-Belts by Goodyear that stayed matched on the drive or in storage.



A REVOLUTION IN POWER TRANSMISSION was launched by the complete line of V-belts with the Green Seal—Compass-V-Steel, HY-T, E-C Cord, and the compact new HY-T WEDGE. With P.D. (positive drive) and Variable Speed Belts, they combine to offer Goodyear belts of unsurpassed quality for every need.

See your Goodyear Distributor or write: Goodyear, Industrial Products Division, Lincoln 2, Nebraska, or Akron 16, Ohio.

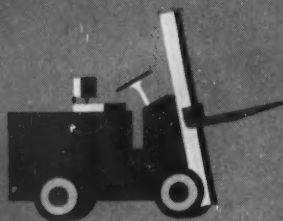
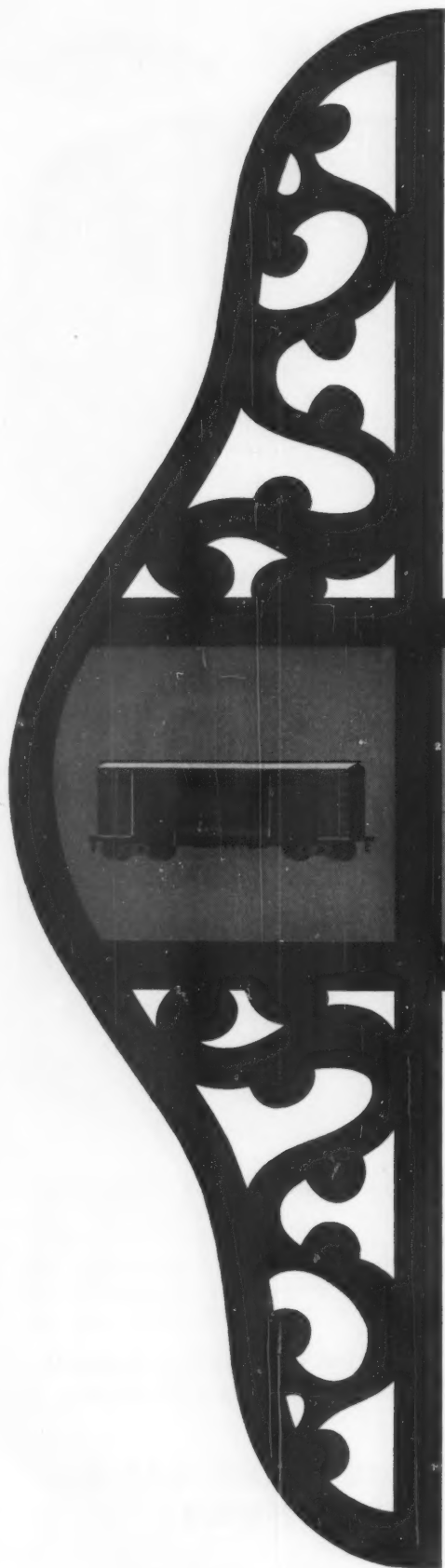
YEAR

THE GREATEST NAME
IN RUBBER

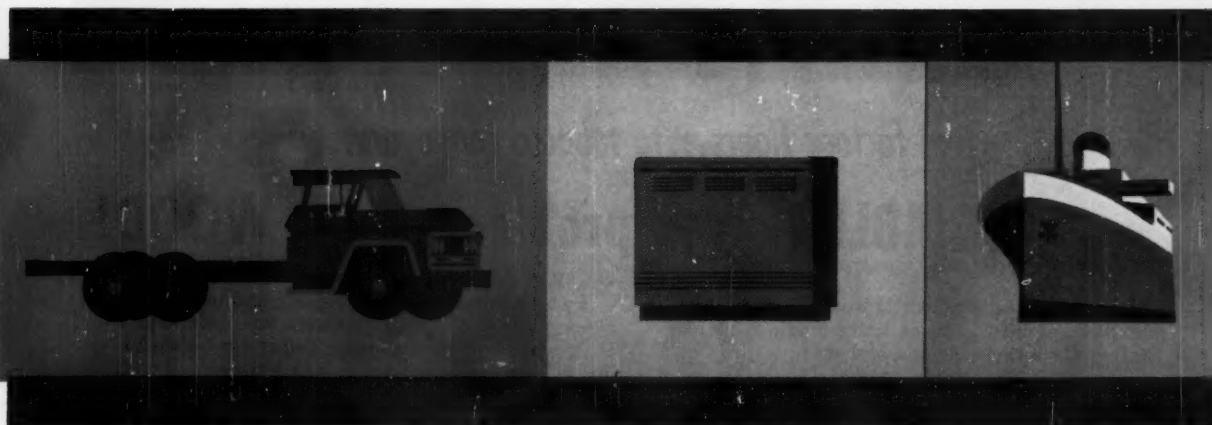
HY-T, Green Seal, E-C, Compass, P.D.-T. M.'s The Goodyear Tire & Rubber Company, Akron, Ohio

DESIGN FOR
LESS WEIGHT AND
LONGER LIFE IN YOUR
PRODUCT WITH

N-A-X HIGH-TENSILE



STEEL



You can design light weight, longer life, and economy into your products by including N-A-X HIGH-TENSILE in your plans and specifications. This versatile, corrosion-resisting, low-alloy, high-strength steel has many attractive features of special value to designers and manufacturers. For example:

- It is 50% stronger than mild carbon steel.
- It offers superior resistance to atmospheric corrosion.
- It has high fatigue life and great toughness.
- It has greater resistance to abrasion or wear.
- It has great paint adhesion, with less underfilm corrosion.
- It is readily welded by any process.
- It is stable against aging.
- It polishes to a high luster at minimum cost.
- It can be cold formed readily into difficult stampings.

With its many diversified applications in modern metal design, it will pay you to investigate N-A-X HIGH-TENSILE for savings in weight, in production time and for longer product life. A thoroughly competent metallurgical service organization is available to work with you on any application problem you may have. Write, wire or phone Product Development Department, Great Lakes Steel Corporation, Detroit 29, Michigan.

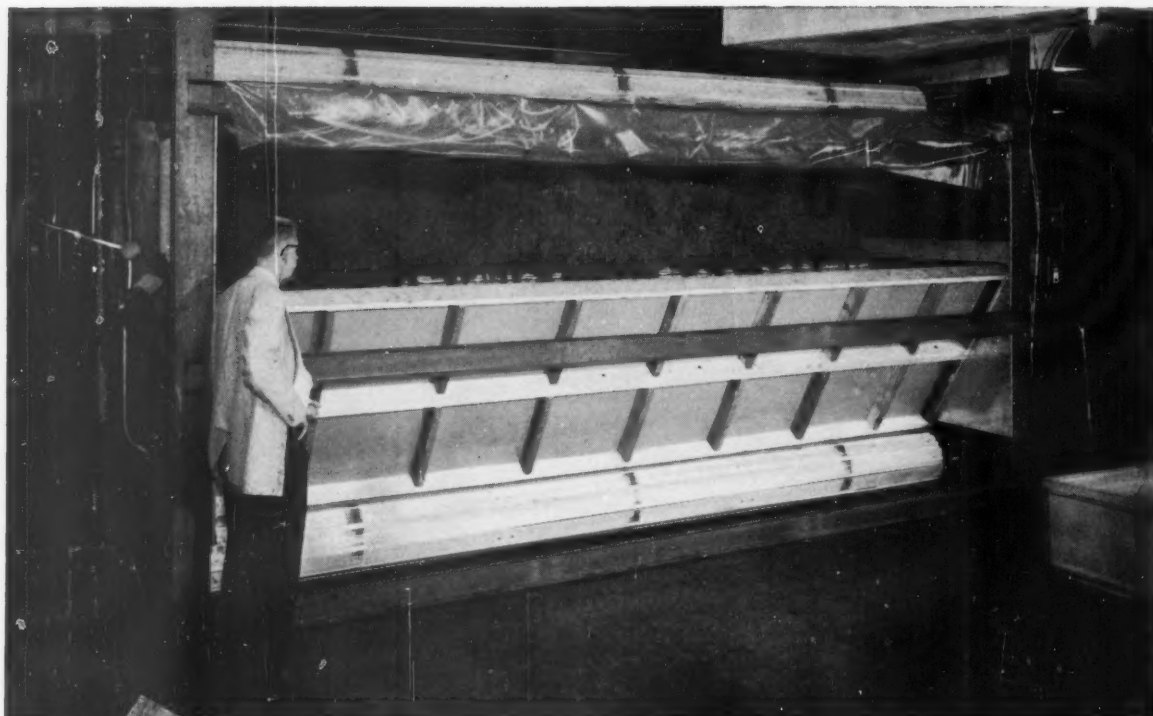


A PRODUCT OF

GREAT LAKES STEEL

Detroit 29, Michigan

Great Lakes Steel is a Division of **NATIONAL STEEL CORPORATION**



from factory floors...to tobacco conveyors...

GAMBLE solves problems with WOOD!

PROBLEM: Ordinary industrial wood block flooring was breaking up rapidly at heavy-traffic spots like loading docks, intersections, and aisles.

SOLUTION: Wood engineers at Gamble Brothers developed a laminated end-grain hickory block which lasts up to 10 times longer, despite punishing loads that quickly break up ordinary flooring.

PROBLEM: Tobacco conveyors required long orifice-forming slats whose dimensions would not change, even after use in a moisture-control operation in cigarette-making.

SOLUTION: Gamble Brothers designed a laminated slat of maximum dimensional stability, bonded by water-proof, heat-proof, non-taste-imparting adhesives. Our facilities enabled us to build the slats under environmental conditions identical to those to be experienced at end use.

Design problems like these are "all in a day's work" to the wood engineers at Gamble Brothers

— a unique organization designing and building a wider variety of wood products than any other U. S. woodworking company. Today they're working in three principal areas: (1) improvement of present wood products (2) development of new wood products (3) product development in combinations of wood and other materials.

Why not present *your* design or component problem to Gamble Brothers? WOOD may be the answer!

FREE booklet illustrates GAMBLE services

This 28-page booklet describes Gamble facilities and services in detail. Includes many photographs of unusual products designed, tested and perfected by Gamble Brothers. Write for your copy today! Gamble Brothers, Inc., 4619 Allmond Ave., Louisville, Ky.



If the problem involves wood, Gamble can help!

GAMBLE BROTHERS, INC.

4619 Allmond Avenue, Louisville, Kentucky

NOW... *Twin-Size*

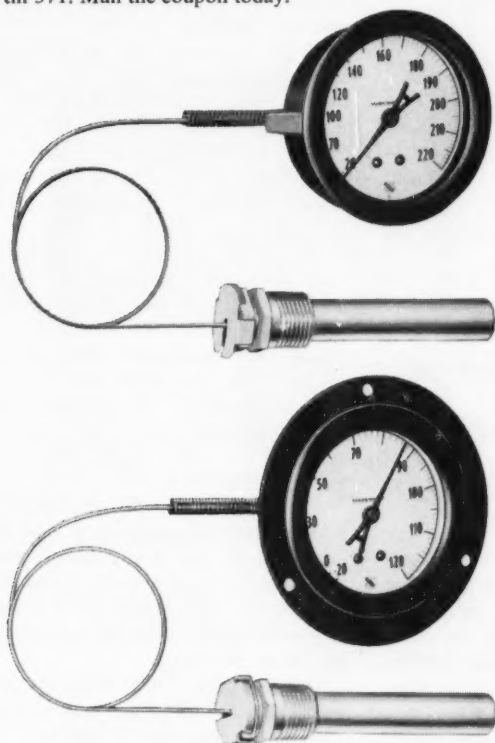
Pressure Gauges and Thermometers for "companion" installation

Appearance rates with high accuracy when gauges and thermometers are essential to the equipment you have "on the boards."

These size-matched pressure and temperature indicators are also similar in case, dial, and pointer design. Such "look alike" characteristics add a quality look to the design of any panel or other mounting surface.

Ashcroft Gauges and American Thermometers have a reputation for sustained accuracy and ruggedness in the most demanding power and processing industry services. Their fine quality is matched by long-term economy on all recommended applications.

Get complete technical data on these 2½" Ashcroft Gauges and American Thermometers, then select those best-suited to the equipment you are engineering. Write for Bulletin 371. Mail the coupon today.

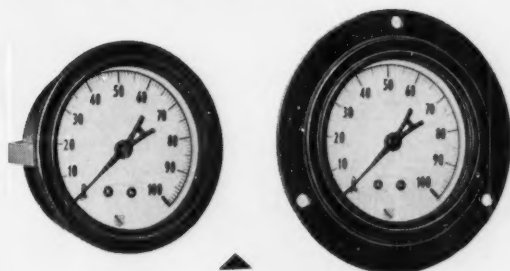


MANNING, MAXWELL & MOORE, INC.



Gauge and Instrument Division
Stratford, Connecticut

In Canada: Manning, Maxwell & Moore
of Canada, Ltd., Galt, Ontario



2½" ASHCROFT GAUGES

"U" Clamp and Front Flange Styles

Steel Case: ⅜" and ¼" NPT centered back connection.

Ranges. Pressure: 0-15 psi to 0-600 psi. Vacuum: 0 to 30" mercury, or 0 to 34 ft. of water. Compound: 15 psi and 30" to 300 psi and 30".

Recommended Applications: For equipment such as portable compressors, pumps, water tanks, industrial washers, and pressure lines.

2½" AMERICAN THERMOMETERS

"U" Clamp and Front Flange Styles

Vapor pressure actuation. Steel case. Plain bulb; or cadmium-plated steel well for corrosion protection.

Ranges. Fahrenheit: Ranges from minus 40°/65° to 260°/450°. Centigrade: Ranges from 0°/100° to 90°/185°.

Recommended Applications: For air conditioning units, oil circulating systems, farm milk tanks, commercial frozen food cabinets, walk-in coolers, refrigeration lines.

WRITE FOR BULLETIN 371

Manning, Maxwell & Moore, Inc.
East Main Street, Stratford, Connecticut

Send me complete technical information on

- ☐ 2½" Ashcroft Gauges
☐ 2½" American Thermometers

Name _____

Title _____

Company _____

Address _____

City/Zone _____ State _____

OZALID NEWSLETTER

NEW IDEAS TO HELP YOU WITH ENGINEERING REPRODUCTION AND DRAFTING



A simple sponge with new Duratrace is your quickest way to renew soiled drawings.

New washable, scrubbable Duratrace® gives you indestructible masters you can sponge new!

If ever there was a drafting film that "is forever," Duratrace is it. New Ozalid Duratrace, when used with modern plastic pencils, can be wiped clean and thereby restored to new condition at the sweep of a sponge. Drawings, originally done in regular pencil or India ink, can also be cleaned, although a bit more care might be necessary.

Just combine this cleanability with

the fact that Duratrace never yellows or ghosts, and you've got a winner that's hard to match on any count. And how about *this? Duratrace either exceeds or equals any other tracing material as far as dimensional stability is concerned!*

Want even more? Just check Duratrace on acceptability of a pencil image! Never has a drafting film equaled New Ozalid Duratrace on

pencil acceptability. But the proof is really in the doing. There are intangibles that exist between a draftsman and his materials that are hard to fully describe. Only your own experience with Duratrace can completely convince you. We think that Duratrace has a certain "feel" that makes it a delight and a joy to work with. Hundreds of draftsmen agree with us. Why not try Duratrace today? Someday, someone might improve on this. Bet we'll be the ones to do it. On every count, doesn't it make sense to try Duratrace?

If you like 'em stacked for speed...

Just check our Ozalid Streamliner 200 Direct Copy Machine.

Fast? A neat 14 feet per minute. Perfect for medium-sized operations and easy feeding.

Wide? A roomy 42 inches that takes four 8½ x 11 sheets in a row, does them as fast as smaller machines do a single sheet.

And the new close-up controls of the 200 cuts operator fatigue; means anyone can learn to operate it in minutes.

New stacking system cuts work time considerably while the new cooling system means greater comfort for everyone in the office.

But these are just the basic facts of operation. How about versatility? The Streamliner 200 is specifically designed as a double-duty unit equally suitable for both engineering and general office work.

Just invest in one Streamliner 200 and get both an engineering and an office unit in one. You get the benefits of engineering speeds and width in your technical work *plus* a super high-efficiency unit for office copying and order invoicing.

One last plug. The Streamliner 200 costs a lot less than you would imagine. It costs less to operate and virtually nothing to maintain. Sold? Just contact your local Ozalid representative for a demonstration.

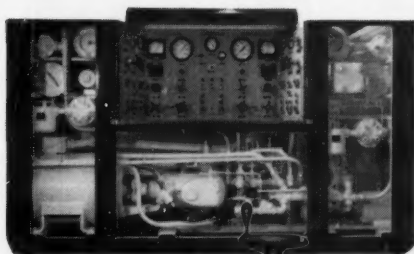
Ozalid, Johnson City, New York. A Division of General Aniline & Film Corp.

Denison and Denison HydrOILics are registered trademarks of Denison Eng. Div., ABSCO

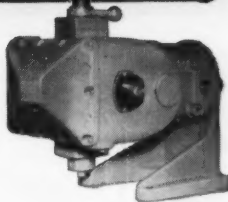


Flexible, high-accuracy
simulation with DENISON
hydraulic pump power for...

CHECKOUT



HYDRAULIC CHECKOUT UNIT, designed and built by Sun Electric Corp., Chicago (shown with access panels removed) is powered by a Denison 800 Series Variable Volume Piston Pump—shown below with handwheel control.



With Denison Variable Volume Axial Piston Pumps powering your hydraulic checkout equipment, you assure *high-accuracy simulation*.

These pumps (with volumes to 116.7 gpm and pressures to 5000 psi) allow a wide range of pressures and flows to be selected with fine-line variations. You get the multi-purpose flexibility needed for today's checkout equipment.

Denison Variable Volume Piston Pumps—and *all* Denison hydraulic components—are precision manufactured for long, maintenance-free life. Result—you can spend more time checking-out...less time checking-up.

Ask your Denison Hydraulics Specialist—located in all principal cities—to show you how Denison hydraulic equipment—pumps, motors, valves, controls—can help you improve the performance of your GSE systems.

Write for your copy of new Bulletin 204, "Advanced Hydraulic Components For Ground Support Equipment".

DENISON ENGINEERING DIVISION

American Brake Shoe Company

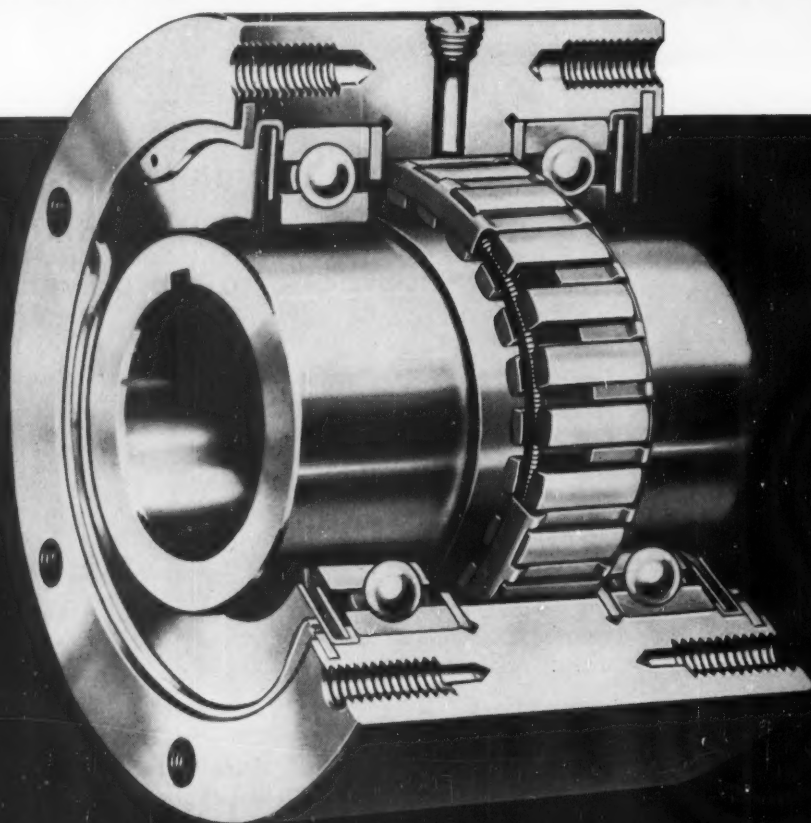
1240 Dublin Road • Columbus 16, Ohio

HYDRAULIC PRESSES
PUMPS • MOTORS • CONTROLS

DENISON

HYDRAULIC POWER

The OVER-RUNNING CLUTCH With



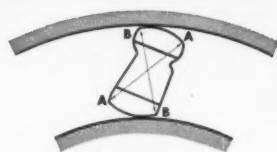
**OVER-RUNNING · INDEXING
BACKSTOPPING**

STANDARD CLUTCHES FOR ORIGINAL EQUIPMENT NEEDS



Formsprag Clutches are used throughout industry, from business machines to aircraft, in bore sizes from $\frac{1}{4}$ " to 12". Several informative bulletins available, including: "Design Considerations for High-Speed Over-running Clutches," "Ten Design Ideas", "Seven Ways to Reduce Space and Costs", plus the complete Formsprag catalog. Write for any one or all.

HERE'S



The Formsprag clutch consists of a full complement of shaped sprags, or wedges, located between concentric inner and outer races. Power is transmitted from one race to the other by the wedging action of the sprags. Each sprag is so shaped that dimension AA is greater than BB. Rotation of one race in the "driving" direction causes the sprags to wedge, transmitting torque in full from one race to the other.

Greatest Torque Per Inch - Per Ounce

Modern power transmission design demands the utmost torque capacity in an absolute minimum of space. That's why designers in every field specify Formsprag clutches . . . the *modern* way to transmit power on over-running, back-stopping and indexing applications.

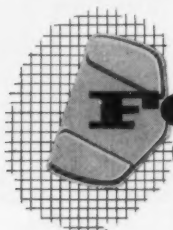
Along with highest possible torque capacity for its size and weight, every Formsprag clutch offers such additional benefits as internal simplicity (just four basic parts), no measurable backlash, light weight, compactness, extreme precision and long, trouble-free life. Formsprag's exclusive, patented principle is unlimited in application, yet this full-complement sprag type clutch is extremely simple in design and operation.

There is a size and model Formsprag

clutch for every application. Standard models include sleeve bearing, ball bearing, miniature, and large bore backstop types. These are shown in the current Formsprag catalog, complete with specifications, performance data and design suggestions. Ask your Formsprag distributor, or write direct for your copy. For special applications, Formsprag engineers will recommend a modified standard or design a special. Send details of your requirements.

FORMSPRAG COMPANY
23603 Hoover Road, Dept. 104
Warren (Detroit), Michigan

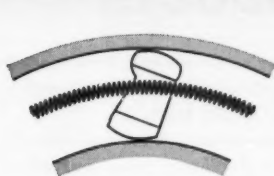
In Canada: Renold Chains Canada, Limited
In United Kingdom: Renold Chains, Limited
Distributors in Principal Cities



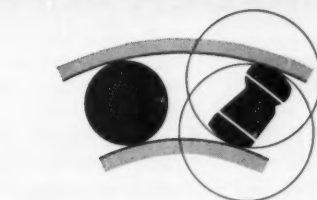
FORMSPRAG CLUTCHES

Precision Power Transmission Products

HOW IT WORKS



An expanding coil spring keeps the sprags in light contact with both inner and outer races. There is thus no lost motion, the driving torque being instantaneously transmitted between races. The Formsprag Clutch is so designed that it will transmit a greater torque in relation to its size and weight, than any other comparable type of clutch . . . specify Formsprag on over-running, back-stopping and indexing applications.

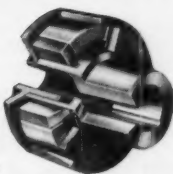


Forcing a ball or roller into a curved, wedged space is an old over-running clutch principle. The sprag is, in effect, a "roller" of increased diameter with greater contact surface in a given annular space. Formsprag Clutches engage at constantly changing contact points. Clutch life is prolonged and backlash eliminated. Also, with the inclined surfaces discarded, more sprags can be inserted to increase torque capacity.

OTHER FORMSPRAG PRECISION PRODUCTS

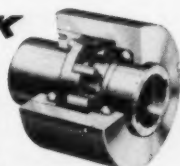
RAWSON Centrifugal Clutches

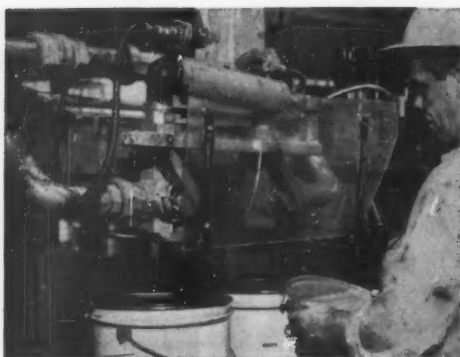
No-Load Motor Starts. Cushioned Starting of High-Inertia Loads, Over-load Protection.



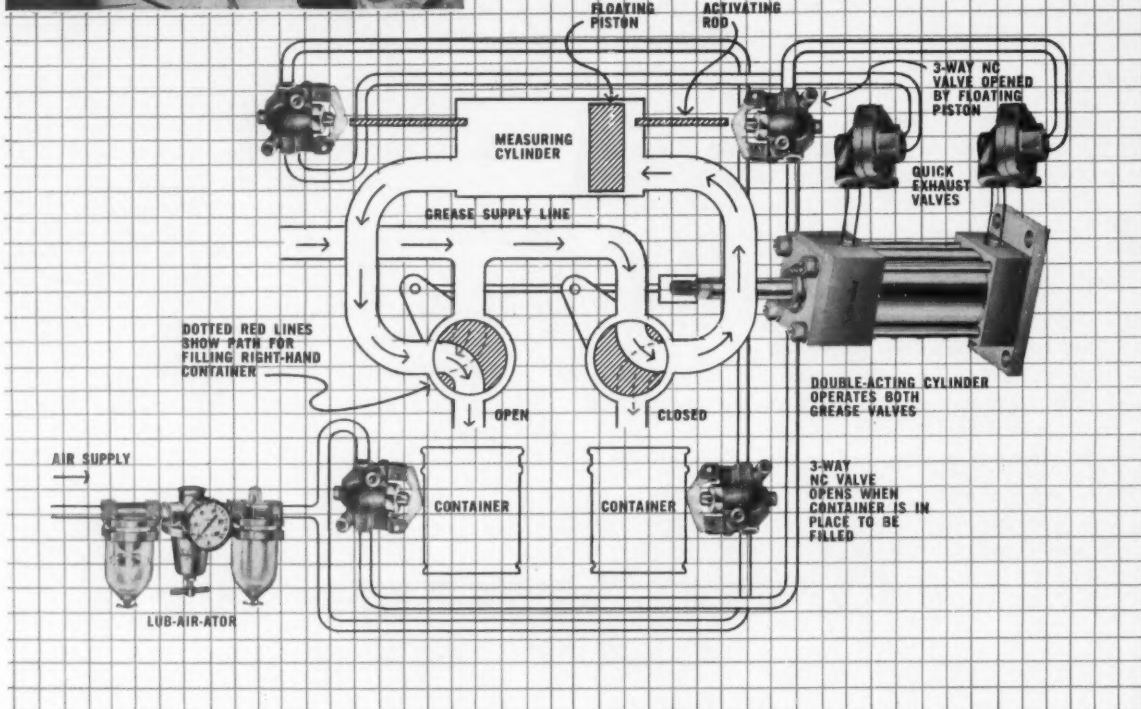
REV'LOK

Dual Torque-Locking and Positioning Device Eliminates Feed-back Torque, Provides Two-Directional Drive, Positioning, Over-running and Backstopping.





Here is an example of Schrader at work. Barrett Mfg. Co. of Houston, Texas, makes grease handling equipment for Mobil Oil's Brooklyn, N. Y., refinery. This machine fills 35 pound grease drums automatically accurately, 15 per minute! George Barrett, who designed and built this machine and other machines for Mobil, says: "My reputation for quality is too hard-won to risk by using some inferior line of air products."



PACKAGING EQUIPMENT MAKER DESIGNS MACHINES TO ORDER...AUTOMATES THEM 100% WITH SCHRADER AIR PRODUCTS

In limitless combinations, Schrader Air Products are performing thousands of jobs in thousands of plants. Wherever jobs are messy, tricky, heavy, monotonous or complicated—it pays to talk to Schrader.

Air is already available to you. Put it to work—on your own operations, or on the equipment you make for resale, like the company shown above. Just tick off its advantages:

high speed and accuracy, low cost and maintenance—plus safety, simplicity, dependability. Air can do almost anything fingers can—and many things fingers can't.

Both you and your customers want these benefits. Get them—and offer them—by actuating with Schrader—finest, most complete lines of Air Cylinders, Valves and Accessories.

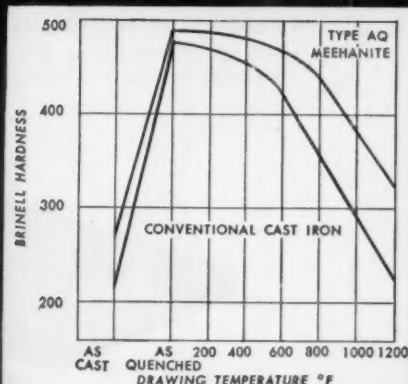
Select from the full Schrader lines to plan your automation of machines. Your Schrader distributor can help you pinpoint what you need. For more data, write:

Schrader
a division of **SCOVILL**

A. SCHRADER'S SON
Division of Scovill Manufacturing Company, Incorporated
476 Vanderbilt Avenue, Brooklyn 38, N. Y.

QUALITY AIR CONTROL PRODUCTS

**NOW
DIMENSIONAL
TOLERANCES
CAN BE HELD
ON HARDENING**



Type AQ Meehanite castings, hardened in air, experience considerably less loss in hardness when subjected to elevated temperatures than ferrous castings hardened by conventional means.

NEW AQ MEEHANITE® . . . keeps distortion to a minimum

AQ Meehanite® is a tough, wear and abrasion resisting material which can be cast to a machinable hardness and air hardened after machining to high Brinell values with little or no distortion, even in massive castings. An outstanding advantage of this new metal is its ability to be locally hardened for improved wear resistance. As no water quenching is required, internal stress is reduced and dimensional tolerances can be held closely. This is particularly important for such parts as dies, punches, cams, rollers, etc.

Type AQ Meehanite is ideally suited for hot forming dies and other parts required to work at elevated temperatures because

it maintains its high hardness even when heated. For this reason, AQ Meehanite castings can be expected to provide good wear resistance where conventional flame hardened parts may soften under repeated temperature influence. See chart above. Large castings can be fully hardened . . . simply . . . economically . . . without oil bath equipment . . . and without dangerous distortions.

Free literature is available on AQ Meehanite. Write to the Meehanite Metal Corporation or contact the nearest Meehanite foundry.

You'll like doing business with a Meehanite foundry.

MEEHANITE METAL

The American Laundry Machinery Co.,
Rochester, N. Y.

Atlas Foundry Co., Detroit, Mich.

Banner Iron Works, St. Louis, Mo.

Barnett Foundry & Machine Co.,
Irvington, N. J.

Casting Service Corp., LaPorte, Indiana
and Bridgman, Michigan

Centrifugally Cast Products Div., The
Shenango Furnace Co., Dover, Ohio

Compton Foundry, Compton, Calif.

The Cooper-Bessemer Corp.,
Mt. Vernon, Ohio and Grove City, Pa.

Crawford & Doherty Foundry Co.,
Portland, Ore.

Dayton Casting Co., Dayton, Ohio

Empire Foundry Co., Tulsa, Okla.

Florence Pipe Foundry & Machine Co.,
Florence, N. J.

Fulton Foundry & Machines Co., Inc.,
Cleveland, Ohio

General Foundry & Mfg., Flint, Mich.

Georgia Iron Works, Augusta, Ga.

Greenlee Foundries, Inc., Chicago, Ill.

Hamilton Foundry Inc., Hamilton, Ohio

Johnstone Foundries, Inc., Grove City, Pa.

Kanawha Manufacturing Co.,
Charleston, W. Va.

Kennedy Van Saun Mfg. & Eng. Corp.,
Danville, Pa.

Lincoln Foundry Corp., Los Angeles, Calif.

Oil City Iron Works, Corsicana, Texas

Palmyra Foundry Co., Inc., Palmyra, N. J.

The Henry Perkins Co., Bridgewater, Mass.

Pohlman Foundry Co., Inc., Buffalo, N. Y.

Rosedale Foundry & Machine Co.,
Pittsburgh, Pa.

Ross-Meehan Foundries, Chattanooga, Tenn.

Sonith Foundries of FMC, Indianapolis, Ind.

Standard Foundry Co., Worcester, Mass.

The Stearns-Roger Mfg. Co., Denver, Colo.

Vulcan Foundry Co., Oakland, Calif.

Washington Iron Works, Seattle, Wash.

Dorr-Oliver-Long, Ltd., Orillia, Ontario

Hartley Foundry Div., London Concrete
Machinery Co., Ltd., Brantford, Ontario

Otis Elevator Co., Ltd., Hamilton, Ontario

MEEHANITE METAL CORPORATION, NEW ROCHELLE, NEW YORK

GRAPHITAR[®] VANES

(CARBON-GRAPHITE)

and long life of CONDE

This rotary positive displacement pump, engineered and produced by the Dri-Air Pump Department of the Conde Milking Machine Company, Inc., of Sherrill, N. Y., is designed to deliver clean, dry air or gas for high vacuum and low pressure applications in hospitals, dental offices, chemical or pharmaceutical plants, industrial processing systems and in metalworking plants. Thanks to vanes of GRAPHITAR, the CONDE Dri-Air Pump gives years of trouble-free, continuous operation at maximum recommended vacuum and speed... *without lubrication!* The GRAPHITAR pump vanes are self-lubricating and are seated by centrifugal force. Operating with a minimum of friction, they become increasingly efficient as the pump is used. In addition to their self-lubricating properties, the GRAPHITAR vanes are hard, light, non-sticking, non-warping and chemically inert. Perhaps these qualities can be utilized to advantage in your products.



Bulletin #20 includes detailed design data along with properties, characteristics and typical applications of GRAPHITAR. Write for your free copy. If you have questions concerning the incorporation of GRAPHITAR parts in your products, our engineers will be glad to assist you.

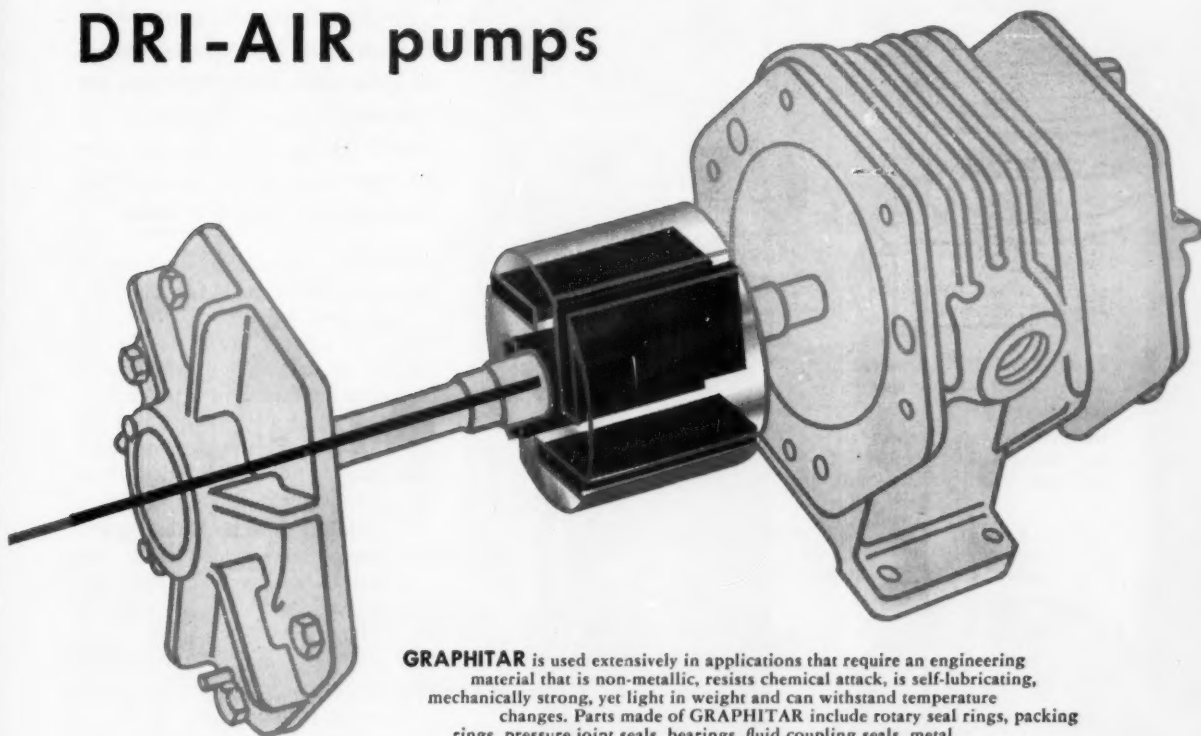


THE UNITED STATES

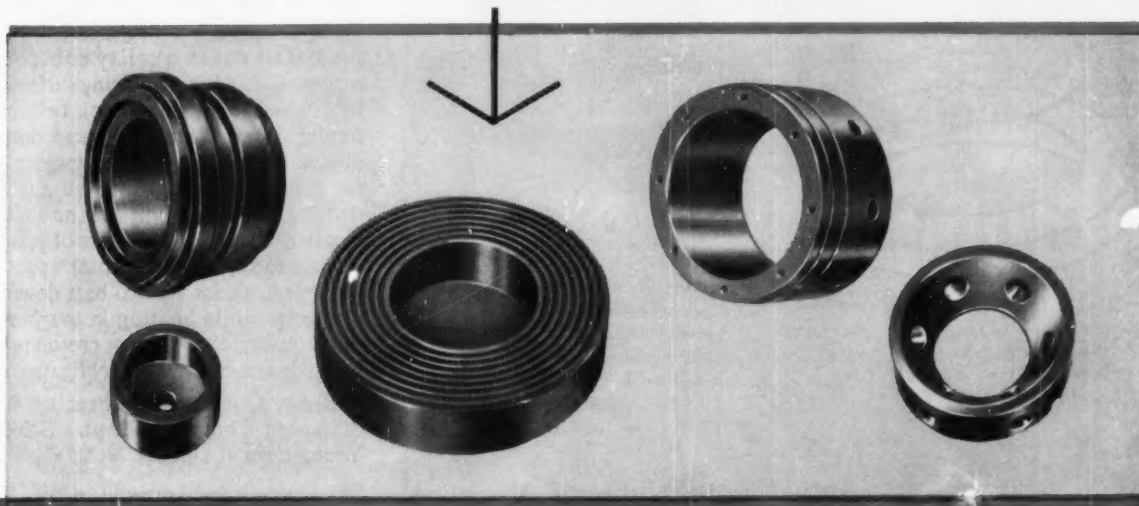
GRAPHITAR[®] CARBON-GRAPHITE • GRAMIX[®] POWDER METALLURGY • MEXICAN[®] GRAPHITE PRODUCTS • USG[®] BRUSHES

help insure efficiency

DRI-AIR pumps



GRAPHITAR is used extensively in applications that require an engineering material that is non-metallic, resists chemical attack, is self-lubricating, mechanically strong, yet light in weight and can withstand temperature changes. Parts made of GRAPHITAR include rotary seal rings, packing rings, pressure joint seals, bearings, fluid coupling seals, metal backed bearings, piston rings and pump liners.

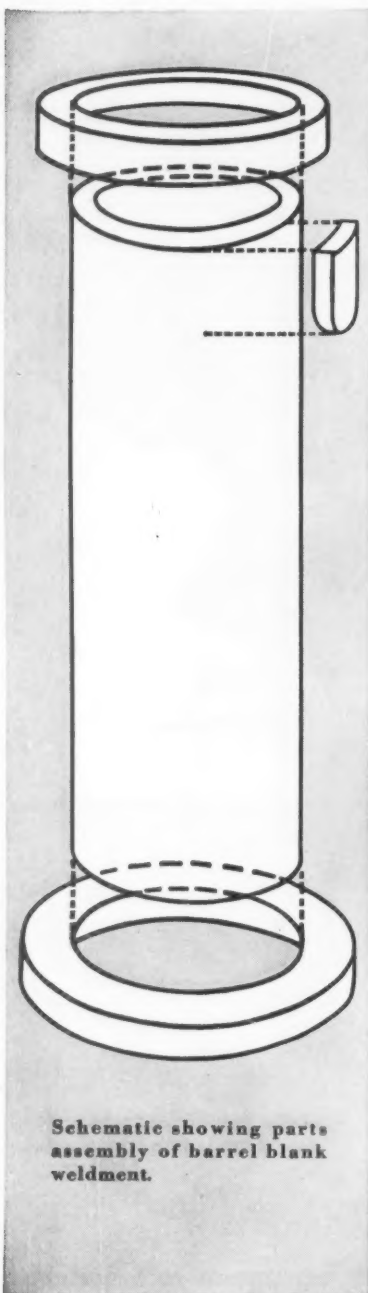


R-285-2

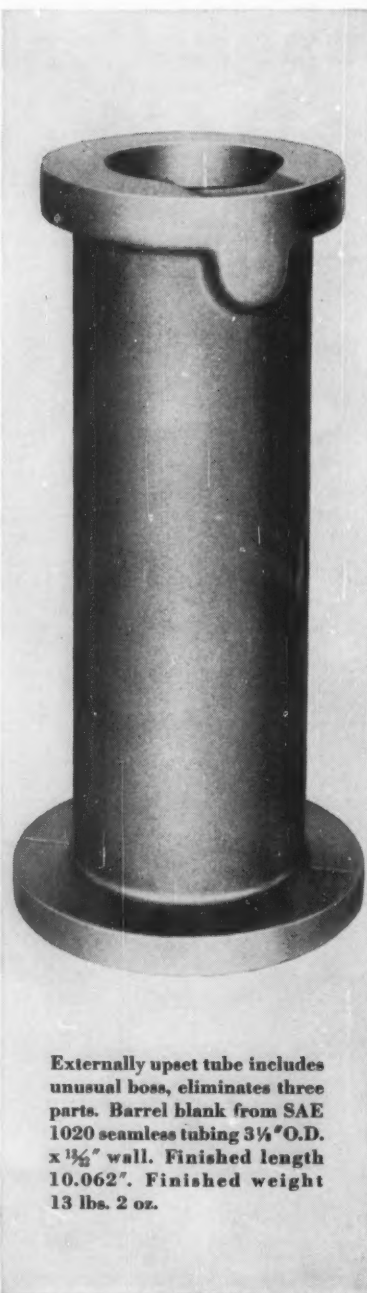
GRAPHITE COMPANY

DIVISION OF THE WICKES CORPORATION, SAGINAW 7, MICHIGAN

Unusual 1-piece design replaces 4-part assembly



Schematic showing parts assembly of barrel blank weldment.



Externally upset tube includes unusual boss, eliminates three parts. Barrel blank from SAE 1020 seamless tubing $3\frac{1}{4}$ " O.D. x $\frac{1}{16}$ " wall. Finished length 10.062". Finished weight 13 lbs. 2 oz.

COMMERCIAL exceeds the commonly accepted technique and specializes in unusual upset forging... combining advanced engineering with practical ingenuity. Here's how!

BARREL BLANK—Originally, the part was a weldment made from a tube, two flanges and a boss. Now, the complete barrel blank is "Task-Forged" by externally upsetting only one piece of tubing in a patterned die designed and developed by COMMERCIAL. This resulted in closer tolerances and less distortion than the previous method.

In addition, as an upset forging the part now possesses added tensile and torsional strength resulting from controlled grain flow while the metal is being displaced. Even more... the part now has a more efficient metal distribution.

Material saving: 15%. Reduced machining time: 30%. Overall customer benefit: a better, stronger part at less cost!

COMMERCIAL quality control assures a scale free machining surface by Hydra-Jet descaling stock before forging. And, Magnaglo® inspection double checks the finished forgings for internal seams, grain structure defects. Let the experience of COMMERCIAL's 30 plus years of producing top quality, unusual upset forgings work for you—to beat down unit costs while beating in tougher metal quality. Send print or prototype for study and estimate—no obligation.

Address: Commercial Shearing & Stamping Company, Dept. S-26, Youngstown 1, Ohio.

Magnaglo is registered trademark of the Magnaflux Corporation.

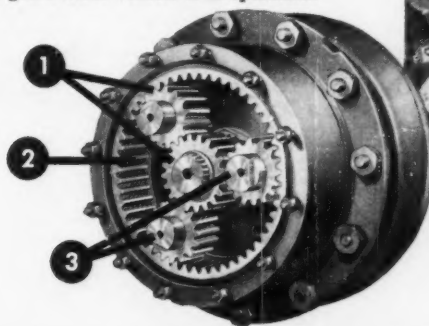
Specialists in the shape of things to come

COMMERCIAL
shearing & stamping



Rockwell's refined full planetary design has these exclusive features:

- 1. FLOATING RING AND SUN GEARS** assure equal distribution of stresses to all planetary gears.
- 2. CONCENTRICALLY MOUNTED RING GEAR** allows perfect alignment and fit—plus freedom of bending forces on hub and spindle splines.
- 3. FORGED ALLOY BRONZE PLANET PINION PINS** have rifle drilled lubrication channels and machined lubrication flats to assure full-time lubrication.
- 4. FULL FLOW LUBRICATION** design gives constant flow of lubricant to wheel bearings and all planet gears while vehicle is in operation.



"TIMKEN-DETROIT® PLANETARY AXLES

BEST DRIVE FOR THE HEAVYWEIGHTS!"

Here's new rugged dependability for prime movers, four-wheel tractors, heavy off-road wagons, mining and agricultural equipment, and many other heavy-duty applications. Rockwell-Standard's complete line of planetary axles are available in capacities up to 150,000 pounds. And to meet every job need, there is a planetary steering axle operationally matched to each rigid planetary in the line.

The large reductions possible with Rockwell's full planetary, double-reduction axles enable them to ideally perform most heavy-duty off-highway operations. Because the substantial planetary reduction is located in the wheel hub, axle shafts and first reduction gears carry only nominal torsional loads—give long trouble-free service. For the best heavy-weight drive, specify Timken-Detroit.

Another Product of...

ROCKWELL-STANDARD
CORPORATION



Transmission and Axle Division, Detroit 32, Michigan

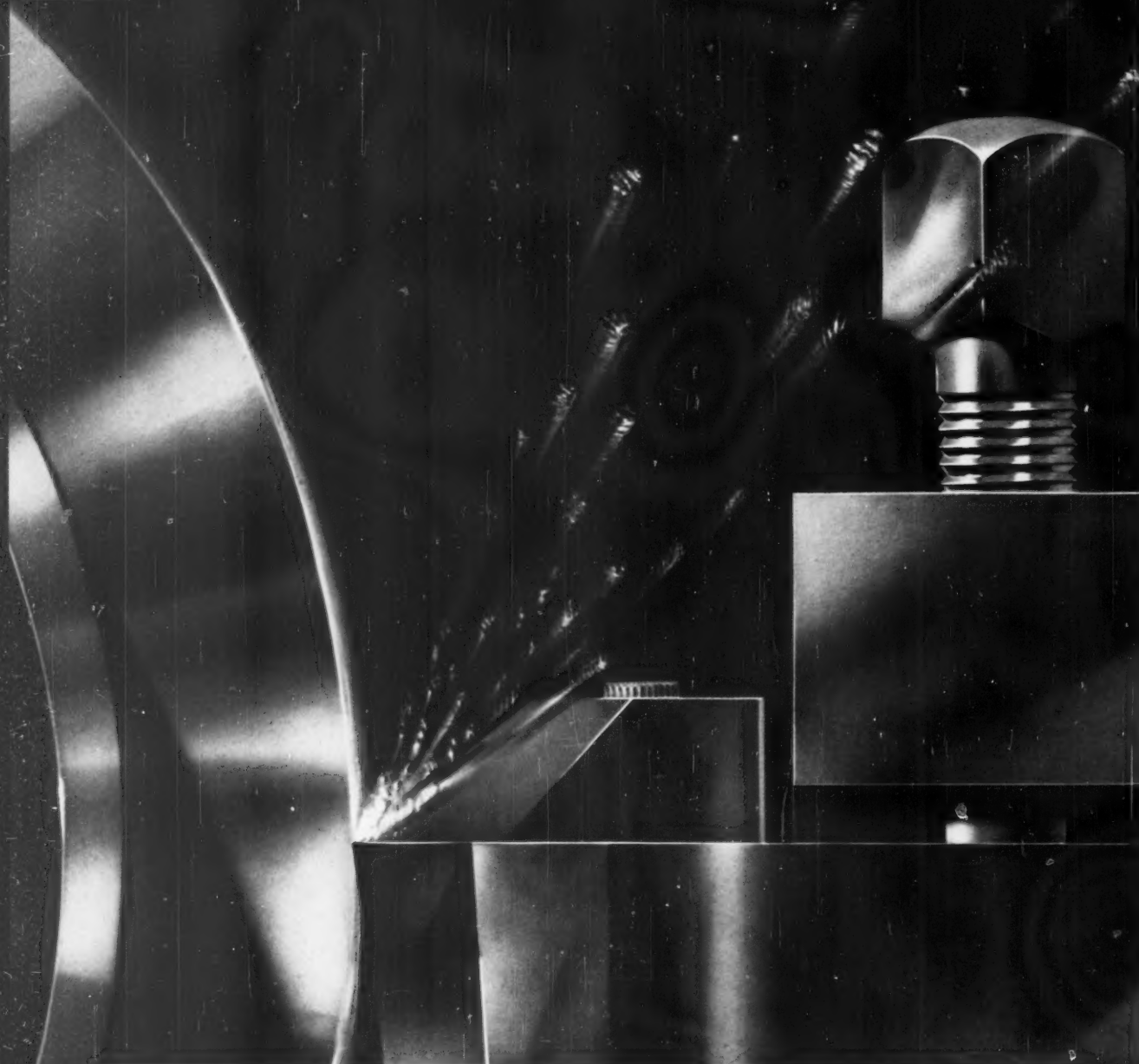


Illustration of Malleable casting being turned at 1,400 surface feet per minute with a 0.100" depth of cut using an oxide tool.

Cut Machining Time and Costs...Use **Malleable**

It's the **finished** cost of machined components that's important to you. Remember then... Malleable iron is the most readily machinable of all ferrous metals of similar properties. With Malleable castings you'll reduce machining time as much as 50%... increase tool life up to 250%... get unexcelled surface finishes.

Find out how much you can cut **your** finished parts costs. Contact any nearby Malleable castings producer who displays this symbol—

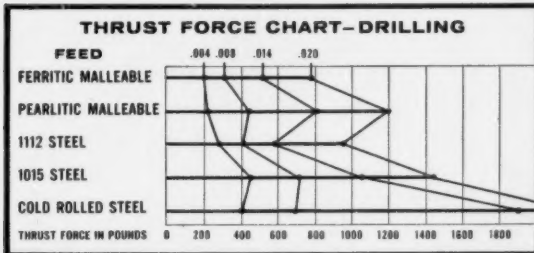


For detailed information on "Machinability of Malleable Castings", contact any of the progressive companies listed on the opposite page, or Malleable Castings Council, Union Commerce Building, Cleveland 14, Ohio.

You'll Get Faster Machining... Better Finished Surfaces... Longer Tool Life with Malleable Castings

Whatever your machining goals—reduced cycle times, lower tool costs or better surface finishes, you will profit from remembering this fact: Malleable is the most machinable of all ferrous metals of comparable properties.

For example, compare the force required to drill Malleable with that required to drill other commonly used metals as we have done here—



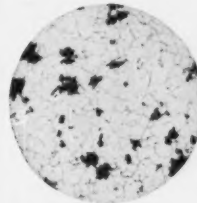
For this test we used 1/4 inch high speed steel twist drills with a suitable lubricant and a spindle speed of 715 RPM. AISI 1112 steel (Bessemer screw stock) was included because it is often used as a standard for machinability comparisons. Since machining may cost 2 to 4 times as much as the rough parts, the superior machinability of Malleable iron, as demonstrated here, can result in very large savings.

Future Promises New Triumphs for Malleable

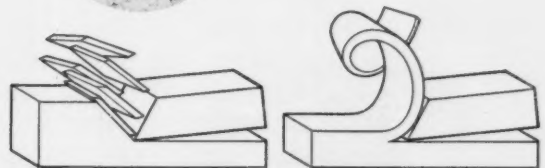
With over two years' experience in advanced machining research, forward-looking Malleable castings producers already know how Malleable will perform when oxide cutting tools come into wide use. In experiments like the one illustrated on the opposite page it has been demonstrated that Malleable can be successfully machined at speeds as high as 1400 surface feet per minute

Chips Reveal the Secret of Malleable's Machinability

In addition to providing strength and ductility, Malleable's internal structure of microscopic carbon nodules allows Malleable to break easily into small chips as it is machined. This kind of Type I chip is highly desirable. Speeds and feeds can be increased... power consumption drops... cutting tools last longer. Malleable's uniform structure permits safe machining at maximum speeds.



Spherical carbon nodules (black) help break up chips. Photomicrograph 50X, etched.



Schematic drawing illustrates how Malleable (left) breaks into short, discontinuous Type I chips, rather than long, continuous Type II and III chips (right).

and a 0.100" depth of cut! Surface finish, tool life and metallurgical structure are excellent... All this in a metal of rugged engineering properties.

Prove for yourself how much Malleable's machinability will do for your products... and your profits. Get in touch with one of the Malleable castings producers listed below. Call today.

Send for Free Machining Information A special folder, *Data Unit 106, Machining Malleable Iron Castings*, is available from the Malleable Castings Council, Union Commerce Building, Cleveland 14, Ohio, or from any member company.



For Quality and Economy... Use

MALLEABLE

For Service in Your Area Contact...

CONNECTICUT

Connecticut Malleable Castings Co., New Haven 6
Eastern Malleable Iron Co., Naugatuck
New Haven Malleable Iron Co., New Haven 4

DELAWARE

Eastern Malleable Iron Co., Wilmington 99

ILLINOIS

Central Fdry. Div., Gen. Motors, Danville
Chicago Malleable Castings Co., Chicago 43
Moline Malleable Iron Co., St. Charles
National Mail and Steel Castings Co., Cicero 50
Peoria Malleable Castings Co., Peoria 1
Wagner Castings Company, Decatur

INDIANA

Albion Malleable Iron Company,
Muncie Division, Muncie
Link-Belt Company, Indianapolis 6
National Mail & Steel Castings Co., Indianapolis 22

IOWA

Iowa Malleable Iron Co., Fairfield

MASSACHUSETTS

Becher Malleable Iron Co., Easton

MICHIGAN

Albion Malleable Iron Co., Albion
Auto Specialties Mfg. Co., Saint Joseph
Cadillac Malleable Iron Co., Cadillac
Central Fdry. Div., Gen. Motors, Saginaw

MINNESOTA

Northern Malleable Iron Co., St. Paul 6

MISSISSIPPI

Mississippi Malleable Iron Co., Meridian

NEW HAMPSHIRE

Laconia Malleable Iron Co., Laconia

NEW YORK

Acme Steel & Mfg. Iron Works, Buffalo 7
Frazer & Jones Company Division
Eastern Malleable Iron Co., Solvay
Oriskany Malleable Iron Co., Inc., Oriskany
Westmoreland Mail Iron Co., Westmoreland

OHIO

American Malleable Castings Co., Marion
Central Fdry. Div., Gen. Motors, Defiance
Dayton Mail Iron Co., Ironton Div., Ironton

Dayton Mail Iron Co., Ohio Mail Div., Columbus 16
Maumee Malleable Castings Co., Toledo 5
National Mail and Steel Castings Co., Cleveland 6

PENNSYLVANIA

Buck Iron Company, Inc., Philadelphia 22
Erie Malleable Iron Co., Erie
Lancaster Malleable Castings Co., Lancaster
Lehigh Foundries Company, Easton
Meadville Malleable Iron Co., Meadville
Pennsylvania Malleable Iron Corp., Lancaster

TEXAS

Texas Foundries, Inc., Lufkin

WEST VIRGINIA

West Virginia Mail Iron Co., Point Pleasant

WISCONSIN

Belle City Malleable Iron Co., Racine
Chain Belt Company, Milwaukee 1
Federal Malleable Company, Inc., West Allis 14
Kirsh Foundry Inc., Beaver Dam
Lakeside Malleable Castings Co., Racine
Milwaukee Malleable & Grey Iron Works, Milwaukee 46

NEW
HAMPSHIRE } **BALL BEARINGS, INC.**
PETERBOROUGH, N. H.

From the office of
ARTHUR N. DANIELS,
President

RE: Instrument Ball Bearings

Gentlemen:

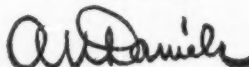
Most of us didn't learn much about anti-friction bearings in Engineering School. In my own case, we learned the difference between ball, roller and needle bearings, and that's about all. Literature on the subject is sparse; the variety of types, sizes and extra features is vast. All have their limitations, advantages and disadvantages.

This is a plea, then, for taking a Bearing Engineer into consultation before your layouts or designs are frozen. He is a professional and his services are free. We have ten of them, at your disposal, in addition to a staff of specialists at our home office.

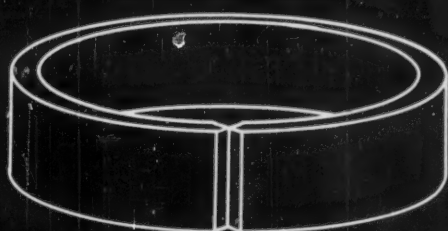
True, they have an axe to grind: to sell you instrument ball bearings. But none of them wants to make recommendations that will fail to meet requirements, or to propose a marginal solution. Ethics of course prohibit their revealing your plans to others. Sometimes they will say "No," or "Maybe," or "Tests must be run." We've not accumulated all the answers yet, doubtless never will. Then, for confirmation, a competitor can be called in. We have a few who know a little about it. And, as sometimes happens among professionals, he may dissent, leaving the judgment up to you.

We believe too that our own new 150-page Design Manual is the most comprehensive treatise on instrument ball bearings published. We shall be glad to send you a registered copy by return mail.

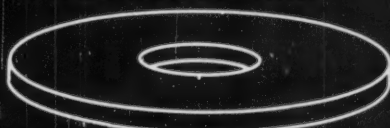
Sincerely,



A. N. Daniels
President



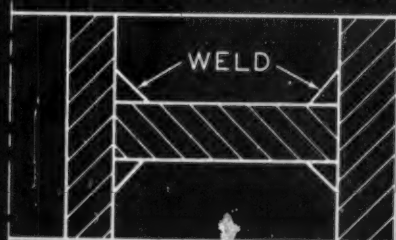
FABRICATED RING



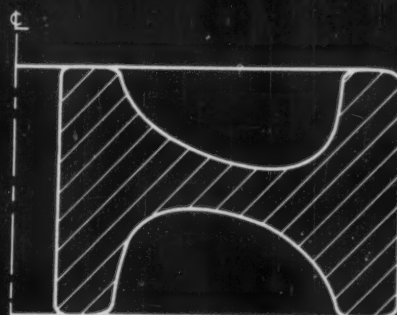
WEB BURNED FROM PLATE



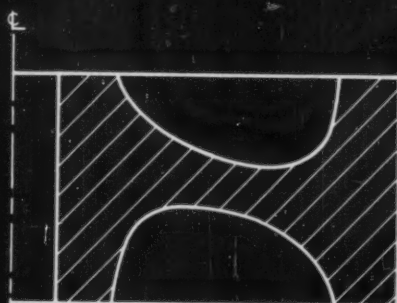
HUB CUT FROM BAR STOCK



DESIRE SECTION



AS ROLLED



ROUGH MACHINED



Why fabricate it?

*(and pay for waste metal,
assembly time, welding?)*

Bethlehem Circular Forgings come ready for finish machining. Unlike a weldment, there's no fabricating to be done. No assembling. No welding. You save the high cost of all those operations—and the cost of the metal those operations waste.

Cost? Thanks to our Slick Mill (the only one of its kind in the country), the cost of Bethlehem Circular Forgings is low. Even if new tooling is required, orders of 20 or more pieces are economical (dies can be changed in just 15 minutes). Our mill forges and rolls an impression-die forging in about one minute. Because contact time between die and

We'll forge it!

*(and cut your costs: less metal,
no assembly or welding)*

work is so brief, and because there's no impacting, low-cost dies can be used.

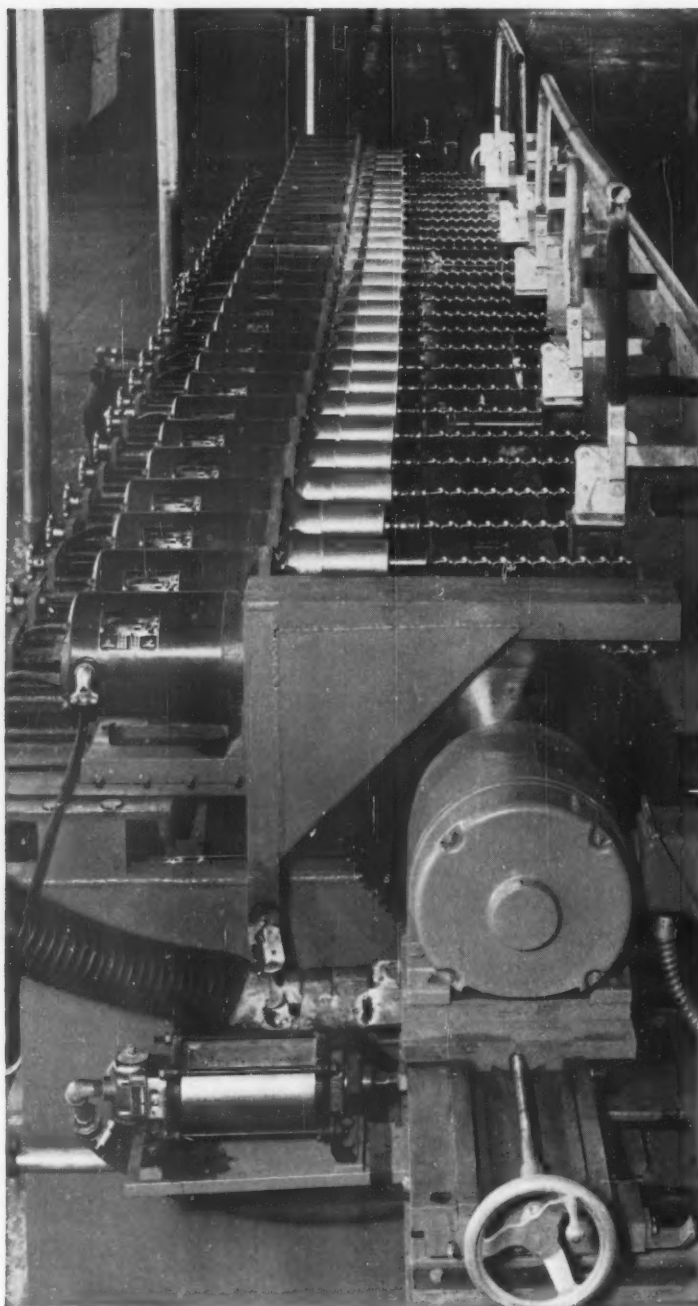
There you have it. One, important fabrication savings. Two, low initial price. That's why forged circular products consistently cost less than weldments.

Bethlehem Circular Forgings are available in carbon, alloy, or stainless steels, and some heat-resistant grades. 10 to 48-in. OD. 100 to 2,000 lb. As-rolled or rough-machined to specifications. For full details, call or write the Bethlehem sales office nearest you.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.
Export Distributor: Bethlehem Steel Export Corporation

BETHLEHEM STEEL





These Wagner Motors Provide...

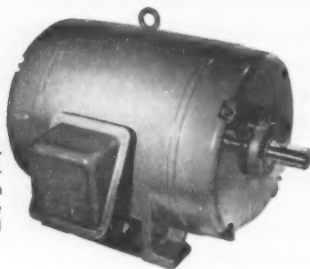
A WHOLE BANK OF POWER FOR HOLE BORING

Those are Wagner polyphase motors lined up behind the bits. Thirty of them, each rated at one horsepower. They provide the muscle needed to drill thirty holes through six 2 x 4's, simultaneously and in six seconds flat. The saw on the end of the rig—powered by a five horsepower Wagner "Doubly Protected" polyphase motor—cuts the boards to size at the same time.

This wood boring machine, manufactured by the Indiana Foundry Machine and Supply Company, is installed in the new Kopper's Company, Inc. Plastics Division plant in Detroit, Michigan.

It's not too often that you see thirty motors lined up like this, providing power for one machine. But, whether the number of motors in a particular application adds up to 3, 30, or 300... if they're Wagner Motors, you know they're really doing a job. That's usual, for Wagner Motors have been getting the job done for more than 65 years. And, a program of constant research and development in electric motor design makes sure that Wagner Motors will continue to lead *where it counts*... in performance!

Mind a suggestion? Call your nearby Wagner Sales Engineer for an analysis of your next motor application, be it for plant or product. Whatever your requirements, Wagner can supply a standard motor, or build a special motor to fit your needs. There are Wagner branches in 32 principal cities across the country, at your service.



Wagner builds Poly-phase Motors in ratings from 1/6 through 1,000 hp.; single phase, 15 hp. and smaller.

BRANCHES AND DISTRIBUTORS IN ALL PRINCIPAL CITIES

Wagner Electric Corporation

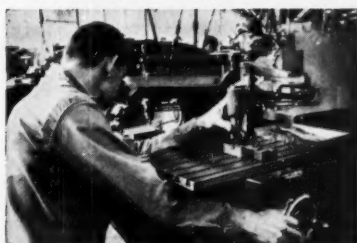
6404 PLYMOUTH AVENUE, ST. LOUIS 33, MISSOURI

WH60-18

SERVING 2 GREAT GROWTH INDUSTRIES—ELECTRICAL • AUTOMOTIVE

 Deam die cast appliance part	 North Amer. Philips nylon coil form	 Dictaphone die cast circuit connector	 Westinghouse insert molded insulating screw	 Sylvania nylon TV tuner part	 Eaton-Autolite die cast instrument gear
 Ronson die cast lighter part	 Stanley die cast power tool part	 Samsonite Interplast hinged luggage closure	 GM acetate car radio part	 Carbide die cast flashlight part	 Argus die cast camera part
 Yale & Towne die cast lock part	 Western Electric Delrin phone dial part	<h2>how many of these 25 GRC small parts ideas can you use in your business?</h2>		 General Electric die cast timer part	 Lionel die cast model train part
 Remington Rand insert cast sensing brush	 Scripps die cast mechanical pencil part			 Allen Bradley die cast & molded control parts	
 IBM insert cast-mold commutator brush	 Detecto die cast scale part			 Natl Cash Reg. nylon adding machine part	
 Stewart Warner nylon speedometer gear	 Minneapolis- Honeywell die cast switch part			 Ford Motor die cast horn part	

Parts shown $\frac{1}{2}$ actual size



Section of our tool shop, where quality starts for GRC TINY ZINC ALLOY DIE CASTINGS and ENGINEERING THERMOPLASTIC MOLDINGS

They are, truly, Shapes of Progress...tiny components that mark Gries' significant and recognized strides in die casting and molding small parts. Each makes a better, more profitable product possible. Yet none could have been made with such high quality...so economically...without GRC's specialized capability: the combination of design experience and unique automated facilities.

What about your idea...your product? GRC gives you design flexibility you may never have thought possible...precision and savings thru 25 years of die casting and molding tiny parts exclusively. *No size is too small...no design too intricate to consider.*

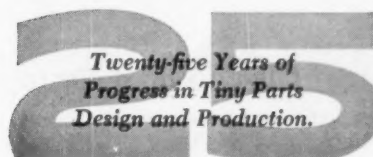
We welcome your inquiries...and offer several significant booklets to help expand your design horizons. Won't you write?

NO SIZE TOO SMALL!
Maximum sizes up to $1\frac{1}{4}$ " $\frac{1}{2}$ oz.

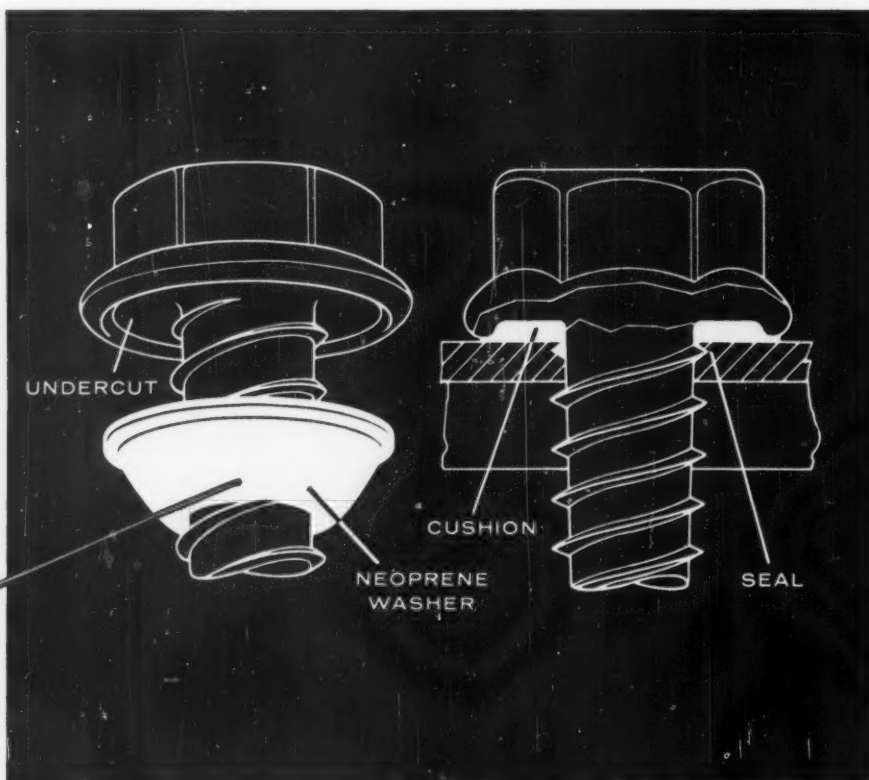
GRIES REPRODUCER CORP.

WORLD'S FOREMOST PRODUCER OF SMALL DIE CASTINGS

32 SECOND ST., NEW ROCHELLE, N. Y. • NEW ROCHELLE 3-8600



NAT'S
quick facts
about
Fasteners...



With **TUFF-TITE** Fasteners TRADEMARK ...it's the **cushion control** that counts!

You can be very sure of this, in using Tuff-Tite® Cushioned Fasteners.

The preassembled neoprene washer won't ooze off in just any old direction when it's compressed under the head.

It will stay put and do what it's intended to do:

- Form a firm, even cushion under the head
 - Seal off the fastener hole
 - Prevent fluid leaking past the thread
 - Dampen vibration noises around the head
 - Protect fine finishes against marring and crazing
- ... because Tuff-Tite's undercut head and tough molded neoprene washer assure consistent cushion control. The undercut confines the spread as the washer is compressed, and the molded

shape guides the flow into the top threads, to seal the hole.

It's as simple and as certain as that, for any application requiring fastener sealing and cushioning. Tuff-Tite Fasteners* are available as Machine, Self-Tapping, or Wood Screws, as Stove and Roofing Bolts, and can also be made as Special Fasteners. We'll be glad to work with you on your possible applications.

*More details and specifications on standard types and sizes are given in the Tuff-Tite Fastener folder. Write for your copy.

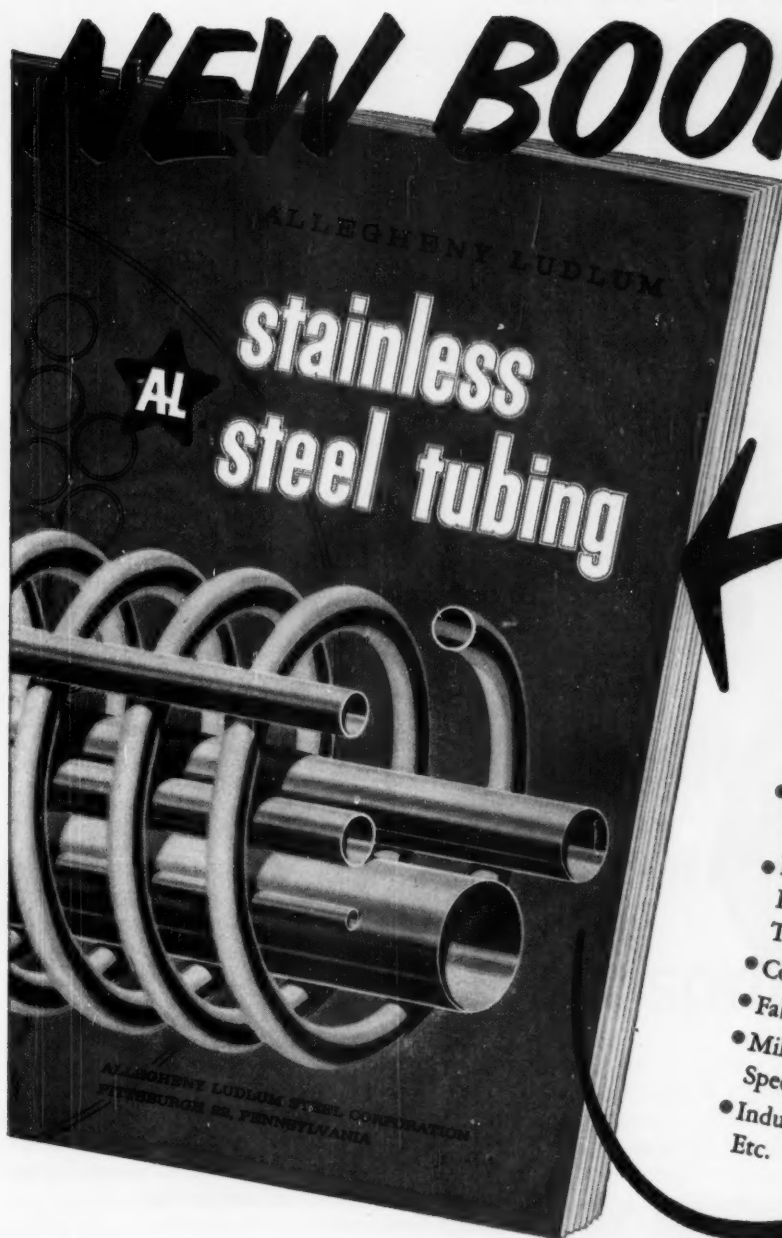


The National Screw & Mfg. Company • Cleveland 4, Ohio

California Division, The National Screw & Mfg. Company • 3423 South Garfield Avenue, Los Angeles 22, California

NEW BOOKLET

on **STAINLESS STEEL TUBING**
sent on request



PARTIAL LIST OF CONTENTS

- Stainless Steel grades
- Product data on Seamless Tubing and Welded Tubing
- Size range Stainless Pipe & Tubing
- Design data—Internal Pressures—Elevated Temperatures, etc.
- Corrosion resistance
- Fabrication data
- Military & Aircraft Specifications
- Industry's uses Etc.

This 36-page booklet newly published by Allegheny Ludlum is packed with technical data and authoritative information on both welded and seamless stainless steel tubing. There are more than 20 tables for ready reference and many photographs.

It will be helpful to design engineers and others interested in solving the many critical and demanding pipe and tubing applications.

The booklet contains the best and latest information available on product and design data on the subject—the partial contents listed give some idea of its scope. You'll want a copy for your files.

Write for your free copy of Allegheny Stainless Steel Tubing, *Allegheny Ludlum Steel Corporation, Oliver Building, Pittsburgh 22, Pennsylvania. Address Dept. MD-6-2.*

ALLEGHENY LUDLUM

Export distribution: AIRCO INTERNATIONAL

EVERY FORM OF STAINLESS . . . EVERY HELP IN USING IT

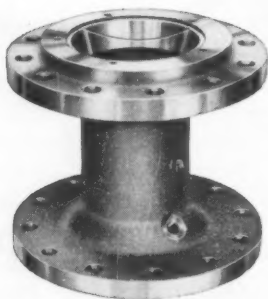
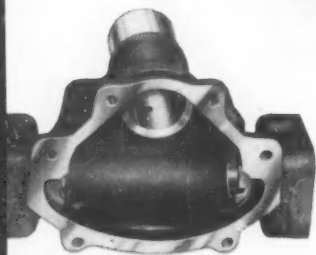
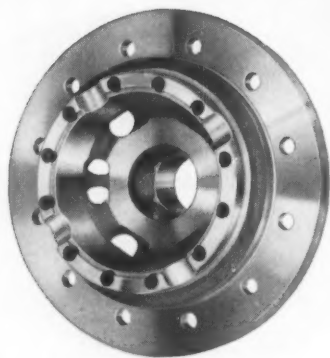


if your twin problems are

product improvement *and* cost reduction

NATIONAL HTM CASTINGS

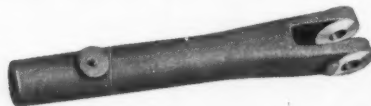
are the answer



HTM is strength...toughness...wear and fatigue resistance...non-seizing. HTM is higher machinability than B1112 steel...it's closer as-cast tolerances that can reduce or wipe out machining operations.

If you're reappraising your product from a competitive point of view...if you're looking for production economies—look into HTM castings. Yes, HTM is many things—and it's just made to order for many mass-produced products just like yours.

A-1151A



NATIONAL MALLEABLE and STEEL CASTINGS COMPANY

Established 1868

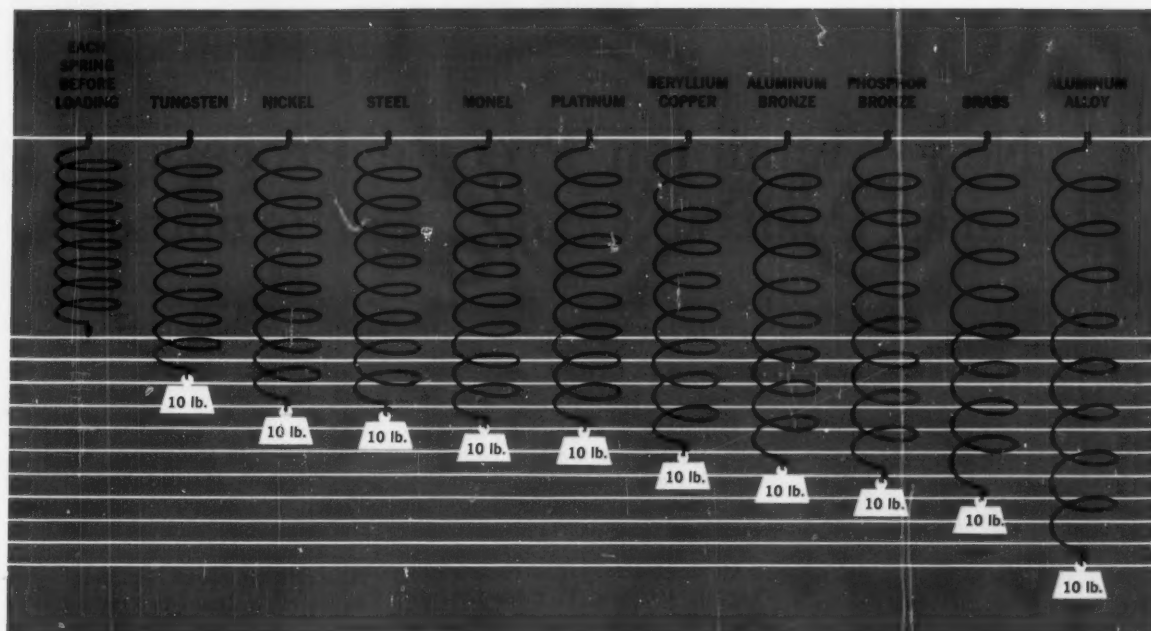
Cleveland 6, Ohio



The nation's largest independent producer of malleable and pearlitic malleable

HTM (Pearlitic Malleable) is many things—and they all add up to a *better product at lower finished cost.*

Circle 479 on Page 19



How much deflection do you want in a spring?



The wide range of stiffness characteristics available in different materials offer unusual opportunity to solve spring deflection problems. How wide is shown in the chart above. The tension springs are all of identical dimensions but of different materials and indicate the relative deflection obtained from applying the same load (assuming the stresses are within safe limits). This basic principle is often

overlooked in the approach to spring selection not only of extension springs but other types: flat, torsion, etc. Because our daily work includes such a wide range of spring usage, we are in a position to help you in the early stages of spring consideration, both in material selection and production short cuts. A handy pamphlet to have at your elbow is our "Metal Selector." Write for your copy.

Associated Spring Corporation



General Offices: Bristol, Connecticut

Wallace Barnes Division, Bristol, Conn. and Syracuse, N. Y.

F. N. Manross and Sons Division, Bristol, Conn.

Dunbar Brothers Division, Bristol, Conn.

Wallace Barnes Steel Division, Bristol, Conn.

Canadian Subsidiary: Wallace Barnes Co., Ltd., Hamilton, Ont. and Montreal, Que.

Raymond Manufacturing Division, Corry, Penna.

Ohio Division, Dayton, Ohio

Cleveland Sales Office, Cleveland, Ohio

Chicago Sales Office, Chicago 46, Ill.

B-G-R Division, Plymouth and Ann Arbor, Mich.

Gibson Division, Mattoon, Ill.

Milwaukee Division, Milwaukee, Wis.

Seaboard Pacific Division, Gardena, Calif.

Puerto Rican Subsidiary: Associated Spring of Puerto Rico, Inc., Carolina, P.R.

New Aluminum Precote Process Insures Positive Gasket Performance

Exclusive Victor Aluminum Precote speeds heat transfer . . . provides higher temperature resistance . . . compensates for irregularities of mating surfaces . . . eliminates need of supplementary gasket cement

This newly developed Aluminum Precote provides simplified gasket installation and insures positive performance on high-temperature engine applications.

Deficiencies in earlier gaskets of this type have been completely eliminated by a new and thoroughly tested aluminum pigmented organic coating, and by refinement of the application method.

New Advantages

- The new processing method permits application of coating to finished gaskets, ready for shipment when coated, thus eliminating possible handling damage.

- Improved coating formula and new application method permit a heavier and completely uniform film on both gasket faces, in controlled thickness from .00075 to .0015 in.

- Controlled baking of coated gaskets at 400 deg. F. gives notably increased resistance to high working temperatures. Precote adhesion to gasket surfaces is improved.

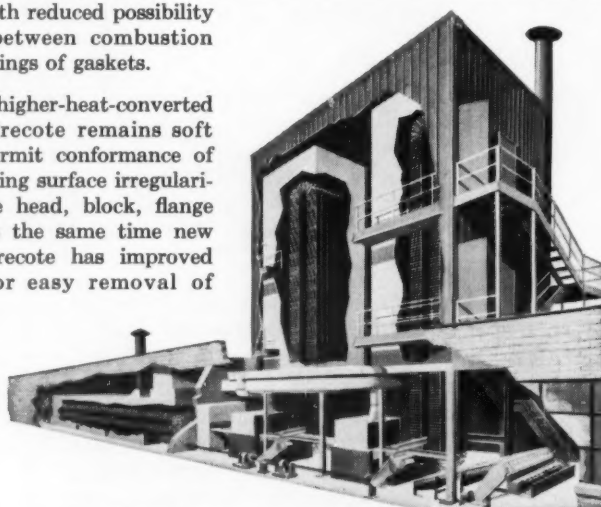
- Resistance to gasket corrosion on contact with antifreeze and coolants is greater—with reduced possibility of blow-by between combustion chamber openings of gaskets.

- The new, higher-heat-converted Aluminum Precote remains soft enough to permit conformance of gasket to mating surface irregularities of engine head, block, flange faces, etc. At the same time new Aluminum Precote has improved properties for easy removal of gaskets.

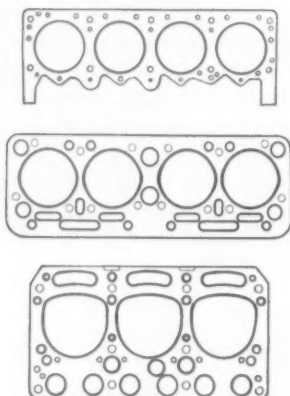
ice—or your inquiry for complete technical data and prices—involves no obligation. Handle through your Victor Field Engineer or direct with the factory. See address below.

New and Improved Facilities Allow High-Capacity Production

Three stories tall, and based on automated conveyor system operation, this Victor installation chemically prepares incoming gaskets, applies and bakes-on Aluminum Precote in



Available Gasket Types and Uses



Improved Aluminum Precote is performing successfully on beaded steel, metal-and-asbestos, metal core, and other gaskets suitable for engine head, manifold, transmission, and similar high-temperature, heavy-duty installations.

For your test purposes Victor will apply—at no charge—this new Aluminum Precote to two or more pieces on any Victor head gasket you are currently using. This serv-

**SAMPLES
FREE...
ON YOUR
OWN
GASKETS**

ice—your inquiry for complete technical data and prices—involves no obligation. Handle through your Victor Field Engineer or direct with the factory. See address below.

Victor Mfg. & Gasket Co., P. O. Box 1333, Chicago 90, Ill. Canadian Plant: St. Thomas, Ontario.

VICTOR GASKETS

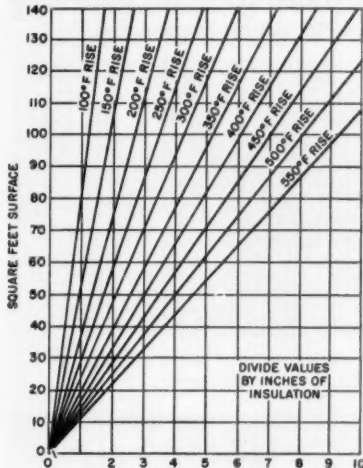
World's leader in gasket design and development
for automotive and industrial application



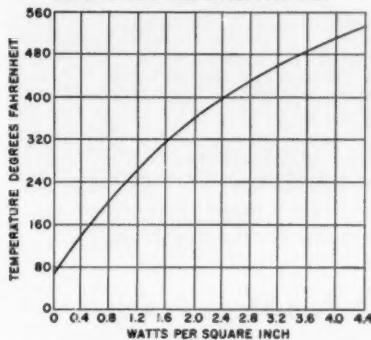
Process Air Heating Guide

How to choose the right amount of heat for ovens and process air applications

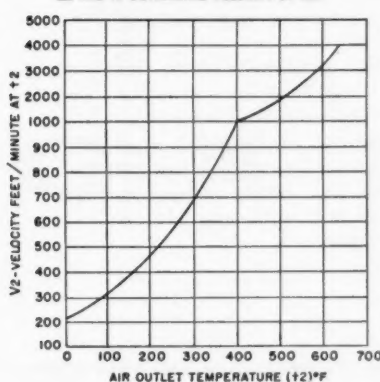
I USE TO DETERMINE LOSSES THROUGH INSULATED WALLS



II USE TO DETERMINE LOSSES FROM ENDS



III USE TO DETERMINE VELOCITY OF AIR

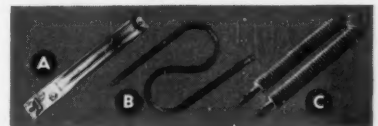


IV This Table Lists Specific Heats

Substance	Average Specific Heat	Weight in lb per Cu Ft
SOLIDS		
Aluminum.....	0.23	160
Antimony.....	.052	423
Asphalt.....	.40	65
Beeswax.....	.031	60
Bismuth.....	.031	610
Brass.....	.10	525
Brickwork and Masonry.....	.220	140
Carbon.....	.204	550
Copper.....	.10	550
Glass.....	.20	165
Graphite.....	.20	130
Iron, cast.....	.13	450
Iron, wrought.....	.12	480
Lead, solid.....	.031	710
Lead, melted.....	.04	550
Nickel.....	.11	550
Paper.....	.45	58
Paraffin.....	.70	56
Pitch, hard.....	.40	83
Rubber.....	.057	95
Silver.....	.057	655
Solder (50% lead—50% tin).....	.04	580
Steel.....	.12	490
Sugar.....	.30	105
Sulphur.....	.203	125
Tallow.....	.06	60
Tin, solid.....	.064	455
Tin, melted.....	.064	455
Type metal (85% lead—15% antimony).....	.040	670
Wood.....	.45	34 pine 50 oak
Zinc.....	.095	445
LIQUIDS		
Acetic acid.....	0.472	66
Alcohol.....	.65	55
Benzine.....	.45	56
Ether.....	.503	46
Glue (mixed 2 parts water, 1 part dry glue).....	.895	69
Glycerine.....	.58	79
Mercury.....	.0333	845
Oil, cottonseed.....	.47	60
Oil, machine.....	.40	58
Oil, olive.....	.471	58
Paraffin, melted.....	.71	56
Petroleum.....	.51	56
Sulphur, melted.....	.234	54
Turpentine.....	.41	54
Water.....	1.0	62.5
GASES		
Acetylene.....	0.35	0.073
Air.....	.237	.080
Alcohol.....	.453	.048
Ammonia.....	.520	.123
Carbon dioxide.....	.203	.078
Carbon monoxide.....	.243	.078
Chlorine.....	.125	.20
Hydrochloric acid.....	.195	.102
Hydrogen.....	3.41	.0056
Methane.....	.60	.0447
Nitrogen.....	.245	.078
Oxygen.....	.218	.09
Sulphur dioxide.....	.155	.179

Here is condensed information to help you get the most economical electric heaters for your oven and process air design problems.

Generally, strip heaters (a) or tubular heaters (b) are used for natural convection applications. For forced convection heating, fin-tubular heaters (c) are most desirable.



Here's how you figure the amount of heat required:

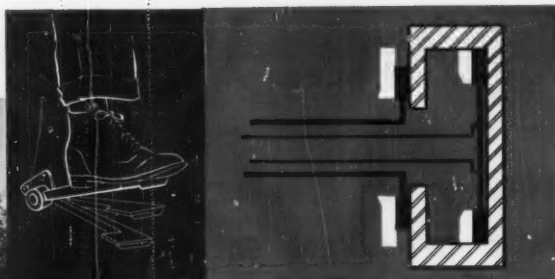
1. Using the formula, lbs of material \times specific ht \times temp rise (F) over 3412 = kwh required, figure heat requirements for the conveyor.
2. Using the above formula, figure heat requirements for the material to be heat treated.
3. Figure total area, in square feet, of top, bottom and both sides of the oven. Check Table I to find total kwh losses. Adjust for insulation.
4. Figure area of both end openings in square inches. Multiply times factor found in Table II.
5. Figure in square feet, the area of the duct. Check Table I for losses. Adjust for insulation.
6. Figure cubic feet of volume of oven and duct. Find weight of air at room temperature from Table IV. Multiply your answer times total cubic feet times number of air changes needed per hour. With this answer, use formula from Step 1 above to find kw needed for air change losses.

Total the answer arrived at in the 6 steps above. Add 3 kw as a safety factor. You now know how much heat is required. For more complete information, send coupon below or call your nearest General Electric Apparatus Sales Office. General Electric Company, Schenectady 5, N. Y.

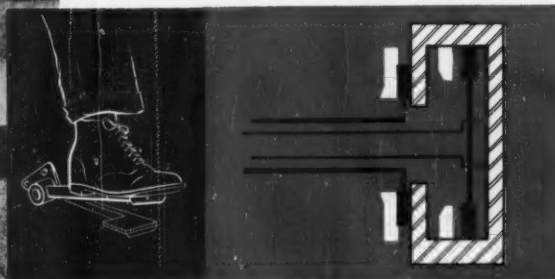
Section F723-28, General Electric Co.
Schenectady 5, New York
Please send GEA-5096, "Heating Process Air" and GEC-1005, "Catalog of G-E Heaters and Devices."

NAME.....
COMPANY.....
ADDRESS.....
CITY.....STATE.....

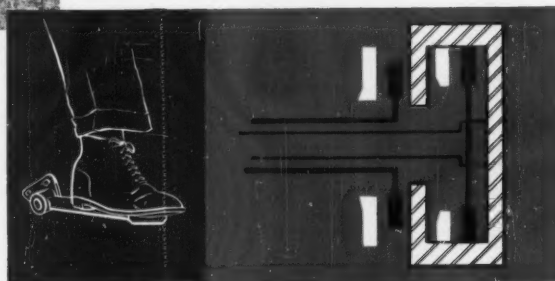
GENERAL ELECTRIC



When the clutch pedal is not depressed, both the transmission and PTO clutches are engaged.



At the halfway mark (you can feel it) only the PTO clutch is engaged. The tractor stops.



When the clutch pedal is fully depressed, both the transmission and PTO drives are disengaged.

SPICER'S DUAL DRIVE TRACTOR CLUTCH . . .

Controls Both The Transmission And PTO With A Single Two-Stage Pedal

In the Spicer Dual Drive Clutch, both the transmission and the PTO drives are operated by a single two-stage foot pedal. This design leaves the operator's hands free at all times for safer steering, faster gear changes and precision implement adjustments.

For added efficiency, the tractor can be stopped while the PTO continues running . . . simply by depressing the clutch pedal to an easily recognized mid-point. This is

a tremendous advantage to the farmer who is baling heavy windrows of hay, picking a high-yield stand of corn, or doing any number of tasks. For greatest safety, the tractor and PTO work may be instantly stopped by completely depressing the pedal.

Add to the safety and efficiency of your tractor design by incorporating a Spicer Dual Drive Clutch. The Dana engineers will be glad to help you with any clutch or transmission problem.



DANA

CORPORATION

Toledo 1, Ohio

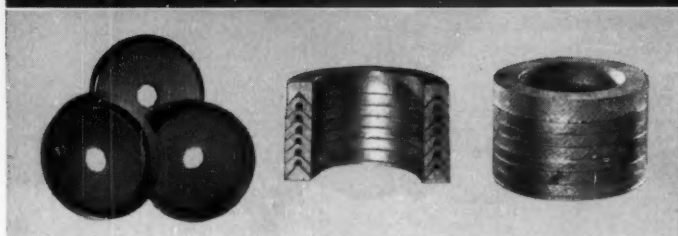
SERVING TRANSPORTATION AND AGRICULTURE —
 Transmissions • Auxiliaries • Universal Joints • Clutches
 Propeller Shafts • Power Take-Offs • Torque Converters
 Axles • Powr-Lok Differentials • Gear Boxes • Forgings
 Stampings • Frames • Railway Drives

Many of these products are manufactured in Canada by Hayes Steel Products Limited, Merriton, Ontario



ENGINEERED PRODUCTS

for Hydraulic, Pneumatic
Service



Garlock "U" Cup and "V" Ring Packings (top) provide tight sealing, help increase efficiency of famous Tomkins-Johnson "Spacemaker" cylinders. Garlock molded cups (bottom left) and CHEVRON* Packings are also specified for air and hydraulic cylinders.

Tomkins-Johnson standardizes on Garlock "U" Cup and "V" Ring Packings for their famous "Spacemaker" air and hydraulic cylinders.

On a wide variety of "Spacemaker" applications, Garlock packings provide leak-proof service against air, water, and hydraulic fluids at temperatures to 250°F, pressures to 1000 p.s.i. Tomkins-Johnson specifies Garlock products because of their greater flexibility, minimum friction, and resistance to sudden shock loads.

Garlock "U" Cup Packings are specially designed for proper fit against the cylinder wall—this prolongs service life to a maximum. Available in several materials and designed to JIC standards, the cups are applied on diameters ranging from 1" through 14". Flexible and resilient Garlock "V" Ring Packings respond quickly to low gland and fluid pressures, offer positive, low friction sealing at all pressures. Available in various materials and sizes.

Enjoy the same advantages that Tomkins-Johnson does—standardize on Garlock hydraulic-pneumatic packings. Garlock's complete line also includes widely-used CHEVRON* Packings with an exclusive hinge-like construction that "rides" with the pressure . . . tightens as pressures increase, eases off as they decline . . . results in positive sealing with little friction. Garlock Molded Cups provide maximum efficiency in sealing air and hydraulic cylinders over a wide range of service conditions.

For more information, call your local Garlock representative at the nearest of our 26 sales offices and warehouses throughout the U.S. and Canada. Or, write for Catalogs AD-163 ("U" Cup

G A R L O C K

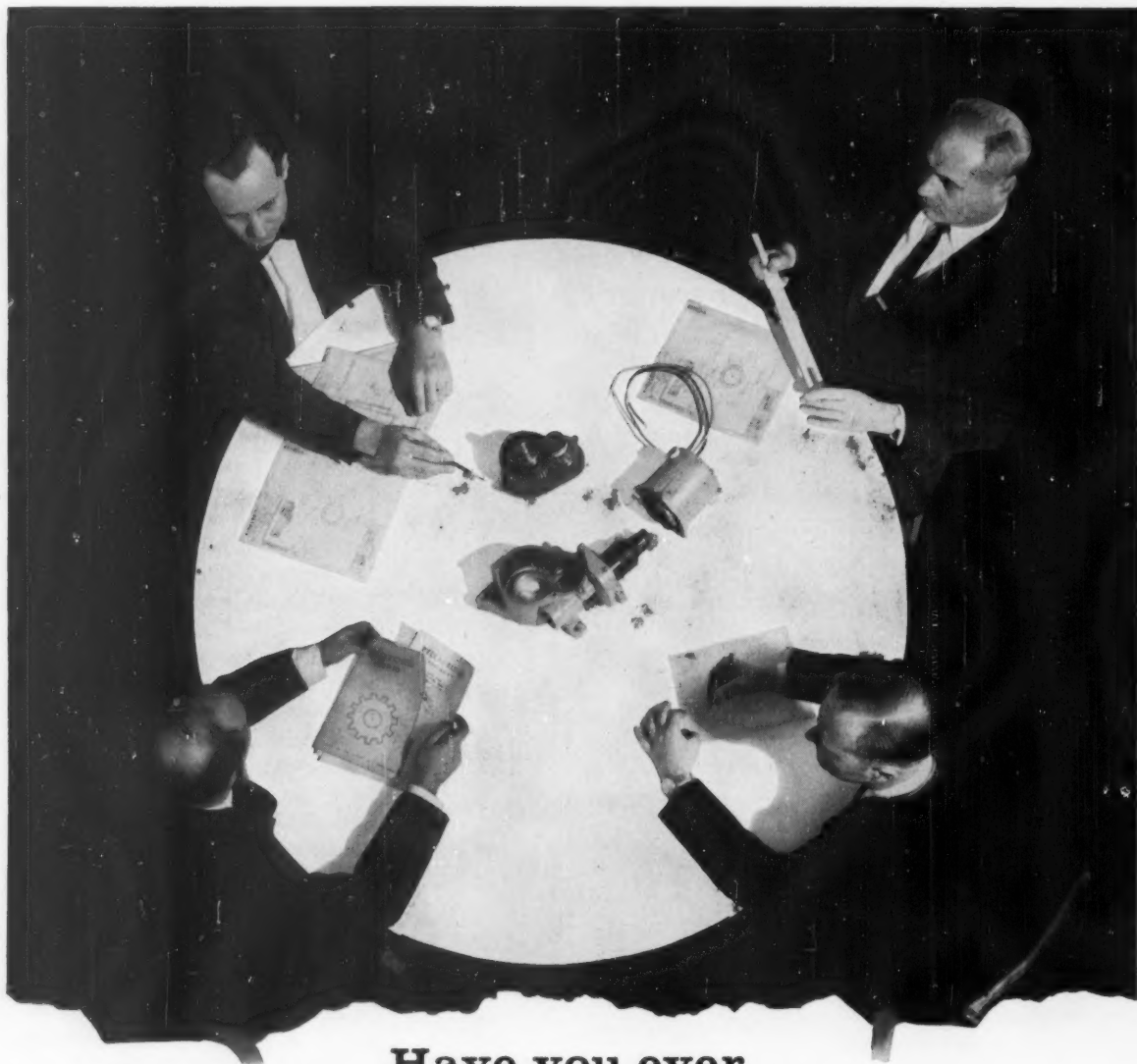
Packings) and AD-115 (CHEVRON Packings). Garlock Inc., Palmyra, New York.

Canadian Div.: Garlock of Canada Ltd.

Plastics Div.: United States Gasket Company

Order from Garlock 2,000 . . . two thousand different styles of Packings, Gaskets, Seals, Molded and Extruded Rubber, Plastic Products

*Registered Trademark



Have you ever attended a Lamb Electric MOTOR CONFERENCE?

If you are planning a new product that will require a Special Fractional Horsepower motor . . . a Lamb District Engineer will set up a "Personalized Motor Conference", just for you.
Result: The RIGHT MOTOR produced at the most favorable cost.

THE LAMB ELECTRIC COMPANY • KENT, OHIO

A Division of American Machine and Metals, Inc.

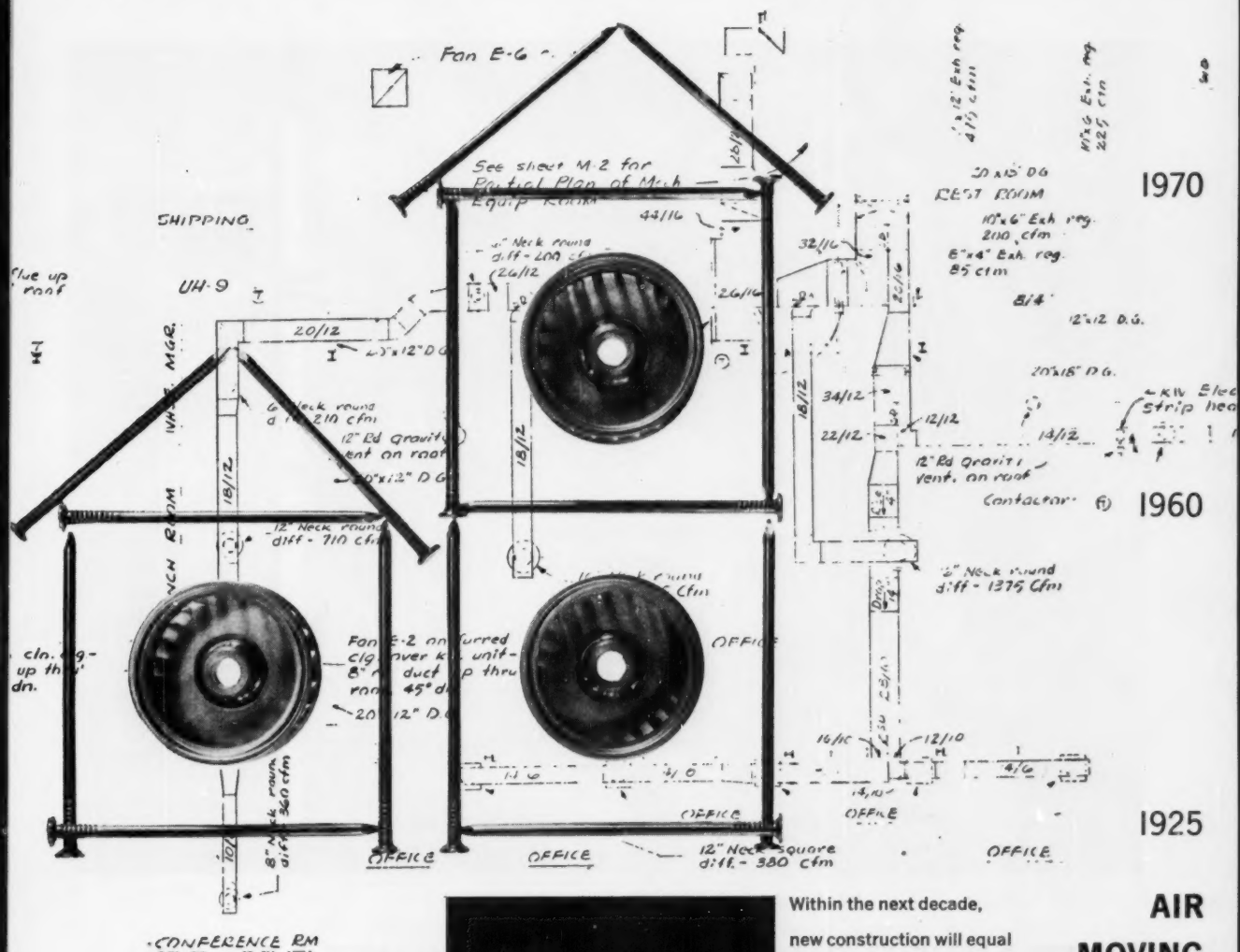
In Canada: Lamb Electric — Division of Sangamo Company Ltd. — Leaside, Ontario



Lamb Electric

SPECIAL APPLICATION
FRACTIONAL HORSEPOWER **MOTORS**

Divisions of American Machine and Metals, Inc., New York 7, New York TROY LAUNDRY MACHINERY
RIEHLE TESTING MACHINES • DE BOTHEZAT FANS • TOLHURST CENTRIFUGALS • FILTRATION ENGINEERS • FILTRATION FABRICS
NIAGARA FILTERS • UNITED STATES GAUGE • RAHM INSTRUMENTS • LAMB ELECTRIC CO. • HUNTER SPRING CO. • GLASER-STEERS CORP.

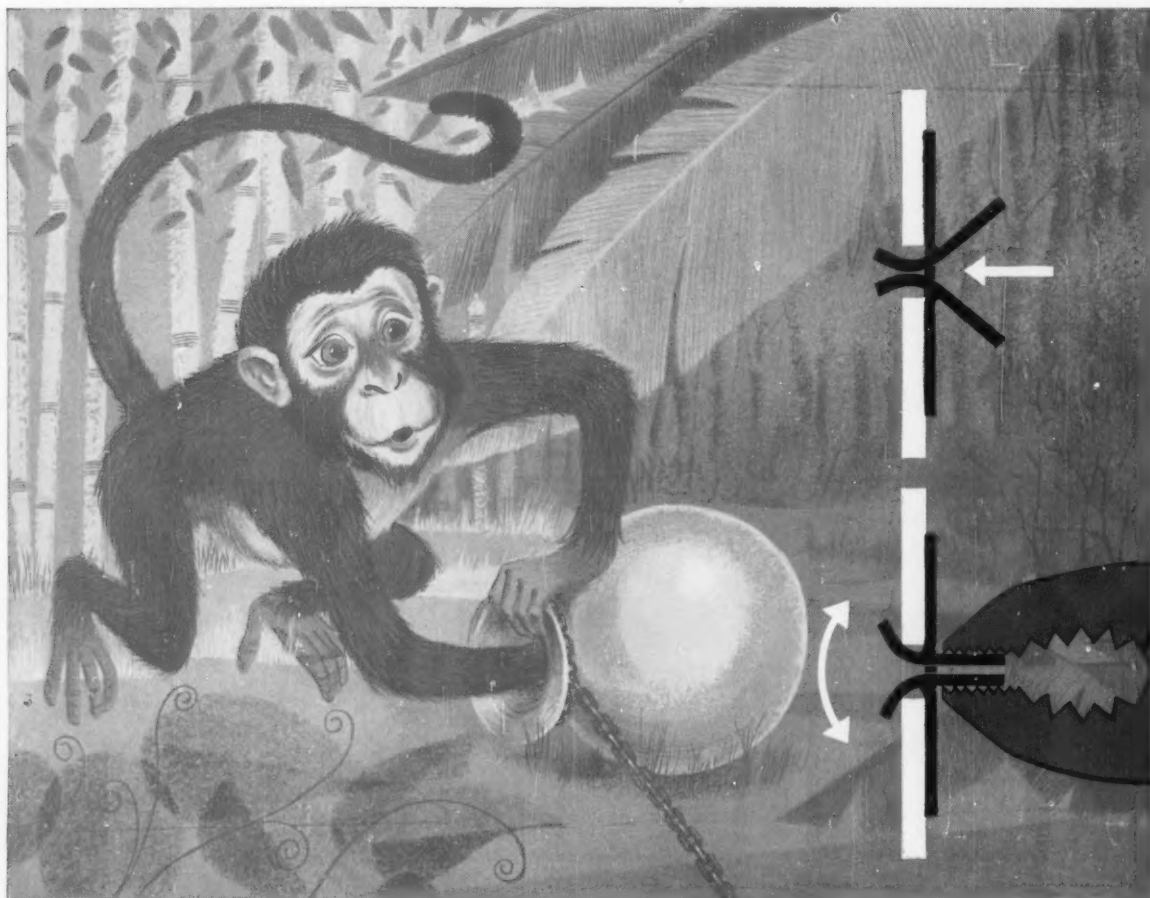


Within the next decade,
new construction will equal
in value the total U. S.
building investment since
1925! This means as
many new ventilating,
heating and air con-
ditioning units as the air
moving industry has
produced in 35 years
—and as many prob-
lems. There is no better
time than now to point
out that Torrington's capa-
bilities in the technology
of moving air—and in
the production of air moving
components—are rated
as the finest in the world.

AIR MOVING FORECAST FOR 1970

THE TORRINGTON MANUFACTURING COMPANY

AIR MOVING DIVISIONS Torrington, Connecticut; Van Nuys, California; Rochester, Indiana; Oakville, Ontario



TRAPPED BY A GRIP THAT WON'T LET GO!

See how Tinnerman "pinch-grips" hold front-mounting attachments; no special equipment needed

Typical of Tinnerman *new approaches to old problems* are "pinch-grip" SPEED CLIPS—permitting front-of-panel applications in a second's time. SPEED CLIPS are simply inserted into mounting holes and a plier's pinch gives permanent retention.

SPEED CLIPS can increase production rates, eliminate rejects, cut assembly costs as much as 50%. Many different features may be incorporated in the SPEED CLIP design to fasten cables, wire harness, rubber feet, mouldings, and for scores of other assemblies.

You may have a fastening problem that can be solved—or a product which can be improved

—by this SPEED CLIP principle. Your Tinnerman specialist (see the Yellow Pages) can furnish samples and help you in many ways. Or write:

TINNERMAN PRODUCTS, INC.
Dept. 12 • P. O. Box 6688 • Cleveland 1, Ohio

TINNERMAN
Speed Nuts®



FASTEST THING IN FASTENINGS®

CANADA: Dominion Fasteners Ltd., Hamilton, Ontario. GREAT BRITAIN: Simmonds Aerocessories Ltd., Treforest, Wales. FRANCE: Simmonds S.A., 3 rue Salomon de Rothschild, Suresnes (Seine). GERMANY: Mecano-Bundy GmbH, Heidelberg.

June 23, 1960



The 1960 Crop

SOME critics, both within and without our ranks, accuse engineers of being obsessed with professionalism. How can "hired help"—as a labor leader put it years ago—consider themselves professional men?

Such a viewpoint reflects a highly superficial view of what a profession really is. Unfortunately it diverts us from some of the attitudes and obligations of a true profession.

One of these is the responsibility to maintain continuity of service to mankind. A profession is concerned with a body of knowledge not possessed by the general public, and with skill in using that knowledge for the public's benefit.

Thus a professional man helps disseminate his own knowledge among his fellow professionals—and also transmits it to the rising generation of professional novices.

At this time of the year, when

more than thirty thousand new graduates are entering industry for the first time, the older engineers are faced with one of their big responsibilities as professional men—the induction of these young men into the working environment of the engineering profession.

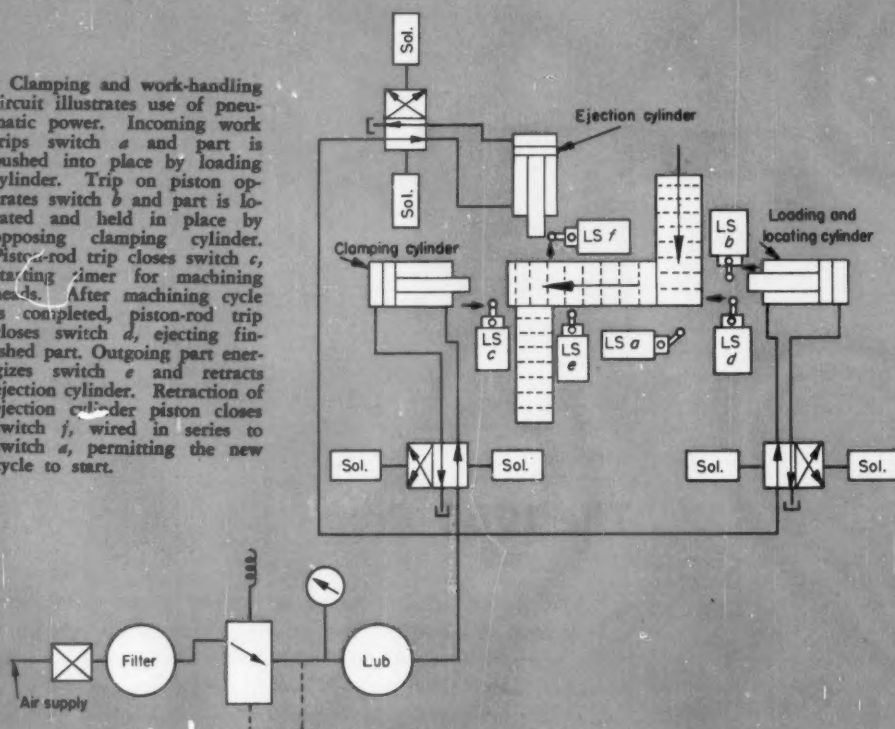
Will these young hopefuls be inspired by examples of dedicated professionalism? Or will they be disillusioned by contact with a "hired-help" mentality to which the challenges of engineering are a bore?

Engineering supervisors, and other experienced men, can do much to develop and foster the spirit of true professionalism in the 1960 crop. Thus they will be insuring the continuity of service which is one of the real purposes of a profession.

Colin Carmichael

EDITOR

Clamping and work-handling circuit illustrates use of pneumatic power. Incoming work trips switch *a* and part is pushed into place by loading cylinder. Trip on piston operates switch *b* and part is located and held in place by opposing clamping cylinder. Piston-rod trip closes switch *c*, starting timer for machining heads. After machining cycle is completed, piston-rod trip closes switch *d*, ejecting finished part. Outgoing part energizes switch *e* and retracts ejection cylinder. Retraction of ejection cylinder piston closes switch *f*, wired in series to switch *a*, permitting the new cycle to start.



Design of **Pneumatic-Power Systems** *Part 1—Applications and Component Selection*

I. LEONARD KAPLAN, Chief Engineer
Lax Industrial Products Inc., Cleveland, Ohio

Fluid systems—pneumatic or hydraulic—are quite similar. However, each has unique advantages in certain applications. Pneumatic power would be best if one or more of your system requirements is: Low cost, low power, cushioning effect, operation in extreme variations of ambient temperatures, or operation in explosive or inflammable environment.

This first article of a two-part series on pneumatic-power systems discusses typical applications and basic circuit components. The concluding article details circuits and component selection to accomplish specific design objectives.

COMPRESSED air can not be surpassed for power and control where economy of initial investment, simplicity of control, and ease of maintenance are desired.

If a central source of compressed air at approximately 100 psi pressure is available, only the control and actuating components need be provided in a new installation.

The majority of applications are designed to operate at 80-100 psi. This pressure standard limits the maximum force or torque produced by a linear or rotary actuator. If higher pressures are required to produce the necessary force within the space limitations a booster must be employed.

In general, the compressibility of air precludes use of a column of entrapped air to lock or to position a moving load in applications requiring extreme accuracy and constancy of position. Accurate positioning of loads in air circuitry requires positive physical stops or abutments to prevent drifting of the load.

Compressed air power is advantageous when:

1. System operates in an explosive atmosphere. Where the cost of electrical controls with explosion-proof ratings might be excessive, air circuits with manual, piloted, or explosion-proof solenoid controls are usually economical.
2. System operates in conjunction with critical processes where contamination from leaking hydraulic circuits can not be tolerated. Food and chemical processes and paper-making are typical operations in this category.
3. System operates in the vicinity of open flames or other high-temperature ignition sources.
4. Application involves severe environmental conditions in which processes must run continuously with no downtime.

Typical Applications

Commonplace applications are primarily complete air-operated machines in individual packages:

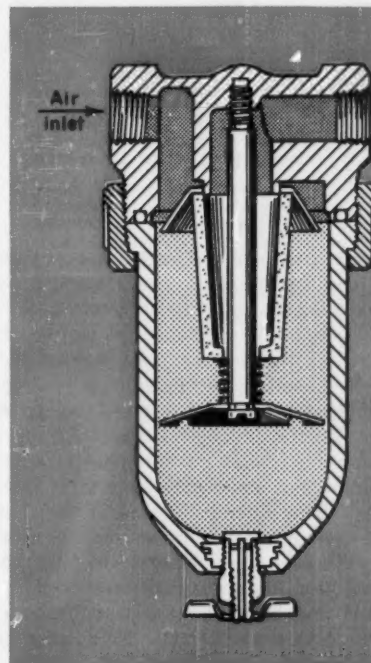
1. Reciprocating air tools—pneumatic rock drills and pneumatic jack hammers.
2. Rotary air tools—drills, nut runners, screw drivers, and impact wrenches.
3. Rotary or reciprocating vibrating equipment.

However, this article discusses pneumatic systems which are designed to produce special machine motions. Selective application of linear or rotary actuators, control valving, feedback or sensing de-

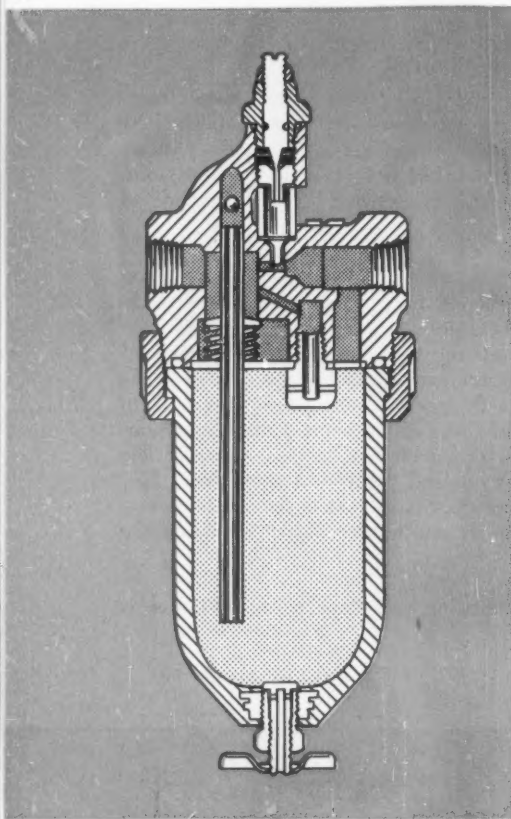
vices, control and power piping, and proper compressed air supply is important to accomplish these ends. Air power circuits may be auxiliary functions on a mechanical or hydraulic machine. Or, they may be the primary and complete mode of actuation.

Transfer or Shuttle: In one of the most common applications, the air transfer circuit moves a workpiece from one station to the next, or a part from one machine to the next in completely automated setups. This circuit may also be used to feed workpieces from a hopper into the work station or to feed strip stock into a punch-press die. Combinations of the basic circuit furnish power to complete complex conveyor and parts-routing systems. Specialized transfer circuits are also effective for rotating workpieces to present a new working face to the machine.

Clamp: Clamping or holding of a workpiece is



Air line filter cleans the air to prevent malfunction of controls.



Air line lubricator lubricates the moving parts of the air system.

another common application for pneumatic power. In most applications, the clamping force is produced directly by a linear actuator or air cylinder. However, mechanical linkages are sometimes added to provide clamping pressures beyond the capabilities of the direct-acting cylinder. Linkages lock the workpiece in position even if air pressure is lost. Such locking linkages protect the operator, or the machine if loss of clamping force occurs.

Guide pins and sockets accurately locate the workpiece. The pins are located in the clamping member, or they may be moved into position by auxiliary cylinders. Indicating devices can be included to signal that the workpiece has been properly positioned and held. Similarly, a feedback signal may be used to reactivate the cycle upon completion of the working operation.

Squeeze: Direct squeezing actions on the workpiece can often be performed satisfactorily by pneumatic power. Riveting, staking, swaging, embossing, coining, blanking, forming, and drawing are

examples. The squeezing action is produced directly by the cylinder, or by air-driven toggle or cam linkages. An air cylinder, driven at high velocity, provides extremely high impact forces over relatively short working strokes.

Feed: Pneumatic power can replace human effort in feeding of drills, reamers, counterbores, chamfering tools, taps and other tools used in the conventional drill press, or drilling machine. Drill-press feed attachments are available commercially but, improvised or special feeds are used to improve productivity and product quality. Air-operated drilling and tapping heads eliminate backlash problems which sometimes make feed attachments troublesome. Air feeds are most often used in light manufacturing operations. Small-hole drilling and secondary operations on die castings, stampings, and other light parts are within the capabilities of these circuits.

Air Springs: An air cylinder connected to a large container of compressed air at a constant pressure acts as a spring with a relatively constant resisting force over its entire stroke. Air-operated die cushions act as springs on press dies used for blanking, forming, and drawing. Properly designed air-operated die cushions require less space than equivalent mechanical cushions. They also increase the capacity of presses which have limited space for cushioning devices under the lower platen.

Shock-absorbers: Air springs absorb more energy than mechanical devices of comparable physical dimensions. Hence, they make good shock absorbers. Air springs can be adjusted to meet varying conditions of velocity and inertia more conveniently than can mechanical bumpers or shock absorbers.

Component Selection

Choosing between a linear or a rotary actuator is the first step in the design of a pneumatic power system. Usually, this choice is controlled by the type of motion desired. Next, all the data on the proposed operation are collected. Data collected include weight to be moved, cyclic rates, velocity of load, force required to move the load or perform other work, special requirements for acceleration or deceleration, and available pressure and air-flow capacities.

Sizing of the actuator is the next step in the procedure. Assuming that unlimited space is available, the three basic factors which determine the size of the air cylinder or torque device are: Available air pressure, force or torque which must be developed by the actuator, and the distance through which this force must be exerted. If there are space

limitations, the size of the actuating device based on available air pressure may be too large. Hence, redesign of the system using a higher operating pressure supplied by a special compressor or pump is necessary.

Items to consider in determining force requirements are: Internal actuator friction, external mechanical friction, external and internal masses to be accelerated or lifted, acceleration required, and other external resistive forces.

In evaluating available pressure, allowance should be made for frictional losses and the effect of demands on the central system by other circuits throughout the plant.

Overtravel is usually permitted on the cylinder stroke. Adjustable mechanical stops provide the vernier adjustment of actuator travel. This procedure simplifies the mounting of the actuator and makes its positioning less critical.

The air-flow capacities based upon the speed and cyclic requirements for the system and the size of the actuator are calculated next. The volume determines the size of the control valves and other accessory items required to complete the circuit. Most manufacturers publish performance data on their valves and other components to aid the designer in selecting the proper one. Flow data are usually shown in terms of pressure drop as a function of flow through the ports in a component. If data are not available, the designer must calculate or estimate frictional loss across each element.

Controls and Accessories

Important accessories in air circuits are the air line filter and the air line lubricator. Clean air—free from dirt, scale, and moisture—prevents jamming and premature failure of the control valves and actuators. Dirt or scale causes galling of metallic parts and excessive wear of seals. Moisture condenses and reacts with the lubricant or other materials.

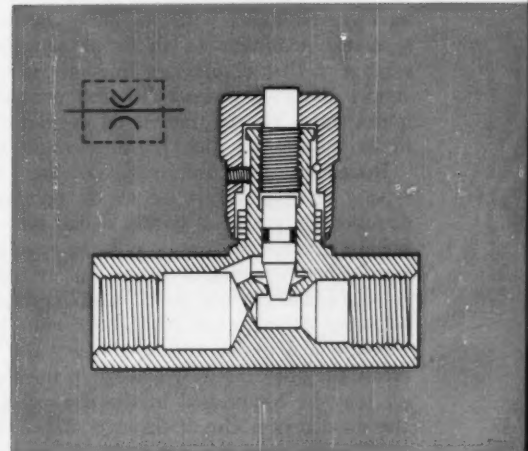
Most control valving and actuators require lubrication of the moving parts. Air line lubricators must provide proper lubrication for all conditions of air flow throughout the system. Lubricators are usually adjustable so that the ratio of oil to air can be set to the optimum point for the system.

Controls for air power circuits are classified as directional, pressure, or volume (flow) controls.

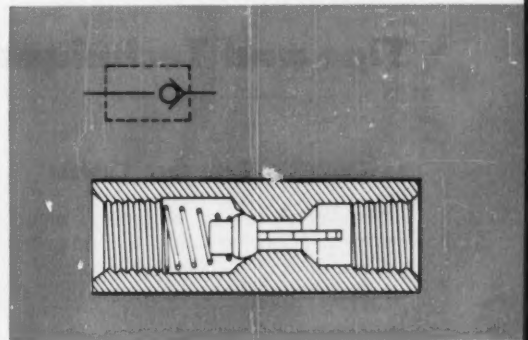
Directional control valves are usually of the spool type. These valves provide for selective connections between pressure source, actuator, and exhaust. The valves operate in response to an externally applied manual, mechanical, or electrical force.

Pressure regulating or reducing valves are usually mounted with the air line filters and lubricators. The valves are commercially available as preassem-

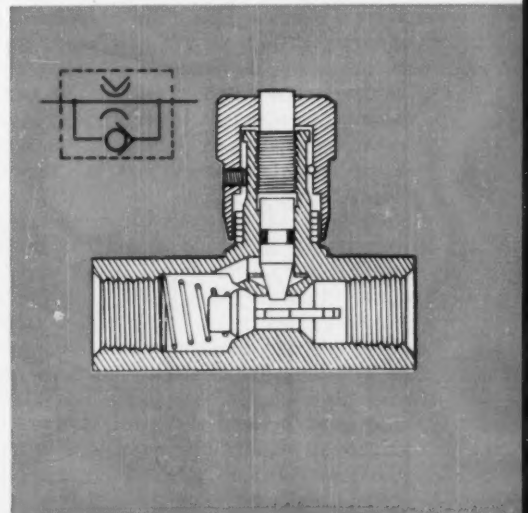
Needle valves regulate the quantity of system air flow.



Check valves permit flow in one direction only.



A check valve and a needle valve are combined in a flow-control valve which permits metered flow in one direction and free flow in the opposite direction.



bled combinations with the other units. Pressure regulators maintain an air supply at constant pressure, regardless of pressure fluctuations in the main supply line. If several different pressures are required in a system, individual regulators are used in the system for each pressure condition.

Reducing valves are usually of the basic poppet type. Therefore, flow of air is permitted in one direction only. In a system which has air flowing at all times, the simple pressure-regulating valve satisfactorily regulates maximum system pressure. In dead-end circuits such as air springs, the line pressure downstream of the reducing valve may increase above the setting of the valve. This increase may be caused by leakage in the regulator, the air may be compressed in the controlled portion of the downstream circuit through some external force on a piston, or, the entrapped air may tend to expand due to heating. To prevent the downstream controlled pressure from rising above the desired value under these conditions, a relief valve is in-

corporated in the system. This valve is built into the reducing valve or is connected to the line just downstream of the regulator. Since built-in relief valves have small capacities, separate relief valves are mandatory if a large amount of air is to be relieved.

Needle or plug valves are basically volume or flow-control devices. Axial positioning of the metering member creates a variable orifice and some form of lock is provided so the orifice is held securely. Calibration of the setting member on a flow-control valve permits duplication of previous flow settings on new setups without the extensive trial and error procedure that would otherwise be required. For those flow-control applications requiring metered flow in one direction and free flow in the opposite direction, a check valve is incorporated into the flow-control valve basic assembly. The basic valve with only the metering element is referred to as a needle valve. A combination unit is termed a flow-control valve.

Tips and Techniques

Reference Cabinet

Handier than a set of drawers mounted in a reference or drawing table is the castored reference cabinet shown. The assembly consists of: 1. A wooden-frame dolly, equipped with casters. 2. Spare draw-



er unit. 3. Plywood top tray. The total height is made so that the cabinet fits under one of the tables for storage. A ready-made assembly of this type, made primarily as a machinist's tool cabinet, can be purchased as an alternate.

The cabinet is positioned beside the drafting table for best convenience in using references, handbooks, or drawing tools.—ANTHONY B. CISTOLA, *International Business Machines Corp., Owego, N. Y.*

Torsional Stiffness and Mass Moment of Inertia

Simplified equations for calculating J , mass moment of inertia, lb-in.-sec², and torsional stiffness K , lb-in./radian, for hollow cylinders and shafts are:

$$J = AL(D^4 - d^4)$$

$$K = \frac{3}{L} (D^4 - d^4)$$

where D = outside diameter; d = inside diameter; L = length. All dimensions are in inches, and constants A and B are given in the table.

Material	A	B
Steel	72×10^{-6}	1.18×10^6
Aluminum	25×10^{-6}	0.39×10^6
Brass	77×10^{-6}	0.49×10^6

—STEPHEN S. LI, *Wright Aeronautical Div., Curtiss-Wright Corp., Wood-Ridge, N. J.*

Patents have often been called a legal form of monopoly—within certain limits. Here's how the courts define the extent of

Patent Owners' Rights

ALBERT WOODRUFF GRAY

Forest Hills, N. Y.

THE OWNER of a patent enjoys certain exclusive rights. He can use his invention or not, as he sees fit. He also can sell or license his patent to any individual or organization, excluding others from similar arrangements. A charge of monopoly in the discriminatory use or disposition of a patent is difficult to prove unless violation of antitrust laws can be clearly shown. The courts in this country, by long precedent, have favored the patent owner and will afford him broad protection against infringement.

THE OWNER of patents on an instrument called the Reflectoscope brought suit against a company for infringement. This instrument is a pulse-echo ultrasonic device for detection of flaws in solid, liquid, or gaseous materials.

The patent owner used the instrument primarily for testing railroad tracks. He maintained a fleet of 19 cars for this purpose and performed approximately 70 per cent of all rail testing in the country. He also was engaged in other commercial-testing work, accounting for a small percentage of the total volume of business in this field.

Defense of the infringement suit rested on the contention that the patent owner's refusal to sell his device to other testing companies was for the purpose of preventing competition and constituted a violation of antimonopoly laws. As a result, the patent owner

forfeited his right to protection against infringement. Disagreeing with this argument, the court said: "The owner of these patents manufactures and sells Reflectoscopes to others for use by the purchasers in testing their own products. All such sales are made without restriction.

"Defendants concede that a patent is the grant of the right to exclude others from using the invention but they advance the novel argument that a refusal to sell the inventions for the purpose of preventing competition with the patent owner in their use is an unlawful enlargement of their grants.

"Merely to state the argument is to expose its fallacy. The argument rests on the presupposition that by this exclusive use of the patented devices in its commercial testing business this patent owner obtained an unfair advantage over its competitors in such business."

Quoting from an earlier decision, the court made this distinction: "Though often so characterized a patent is not, accurately speaking, a monopoly, for it is not created by the executive authority at the expense and to the prejudice of all the community except the grantee of the patent.

"The term monopoly connotes the giving of an exclusive privilege for buying, selling, working or using a thing which the public freely enjoyed prior to the grant. Thus a monopoly takes something from the public. An inventor deprives the public of nothing which it enjoyed before his discovery,

but gives something of value to the community by adding to the sum of human knowledge."¹

Further reference was made to another decision which ruled that defense of an infringement action could not be sustained even when no use had been made by the patentee of his grant: "Whatever may be the policy of patent laws elsewhere it has long been settled in the United States, exclusion of competitors is the very essence of the right conferred by a patent and it is the privilege of any owner of property to use or not to use it without question of motive.

"The fact that the owner of a patent makes no use of it may inspire caution in a doubtful case of validity and lead to hesitation in giving maximum breadth to claims, but if the patent is valid the owner may use it or not as he sees fit."²

THE question of nonuse was brought before the United States Supreme Court early in this century. An action for infringement had been brought by the owner of a patent on a machine for making paper bags. Evidence indicated that the patent owner's machine had not been put into commercial use while the machine claimed to be an infringement had been a commercial success for some years.

The defense contended that the patent was merely a paper patent, unused, and that the patentee, therefore, was not entitled to protection against its infringement. The argument used by the defense charged that invoking such protection would defeat the object of the patent laws.

Holding in favor of the patent owner, the lower court said: "It was suggested at the oral argument that an unused patent is not entitled to the protection given by the extraordinary remedy of an injunction. While this question has not been directly passed upon, so far as we have been informed, in any considered decision of the Supreme Court, yet the weight of authority is in favor of the owner of the patent."

On appeal, the Supreme Court sustained this verdict, adding, "We have seen that it has been the judgment of Congress from the beginning that the sciences and the useful arts could be best advanced by giving an exclusive right to the inventor. The only qualifications ever made was against aliens in the Act of 1832.

"That Act extended the privilege of the patent law to aliens but required them 'to introduce into public use in the United States the invention or improvement within one year from the issuing thereof,' and indulged no intermission of the public use for any period longer than six months.

"A violation of the law rendered the patent void. The act was repealed in 1836. It is manifest that

Congress has not overlooked the subject of non-use of patented inventions. And another fact may be mentioned. In some foreign countries the right granted to an inventor is affected by non-use. This policy, we must assume, Congress has not been ignorant of nor of its effects. It has, nevertheless, selected another policy. It has continued that policy through many years. We may assume that experience has demonstrated its wisdom and beneficial effect upon the arts and sciences."³

ANOTHER action was brought before that high court a few years ago by the United States. Here, antitrust violations had been charged against a group of glass manufacturers. Commenting on the decree granted by the lower court to restrain these companies, the Supreme Court said: "Much is said about the practice of the companies in applying for patents to 'block off' or 'fence in' competing inventions. In the co-operative effort of certain of the companies to obtain dominance in the field of patented glass making machinery, many patents were applied for to prevent others from obtaining patents on improvements which might to some extent limit the return in the way of royalty on original or fundamental inventions.

"The decree should restrain agreements and combinations with this object. But it is another matter to restrain every company for the indefinite future from attempting to patent improvements of machines or processes previously patented and then owned by such company."

Regarding the rights of the inventor in the disposition of his patent, the court added: "A patent owner is not in the position of a quasi-trustee for the public or under any obligation to see that the public acquires the free right to use the invention. He has no obligation to use it or to grant its use to others.

"If he discloses the invention in his application so that it will come to the public domain at the end of the 17-year period of exclusive right, he has fulfilled the only obligation imposed by the statute.

"This has been settled doctrine since at least 1896. Congress has repeatedly been asked and has refused to change the statutory policy by imposing a forfeiture or by a provision for compulsory licensing, if the patent is not used within a specified time.

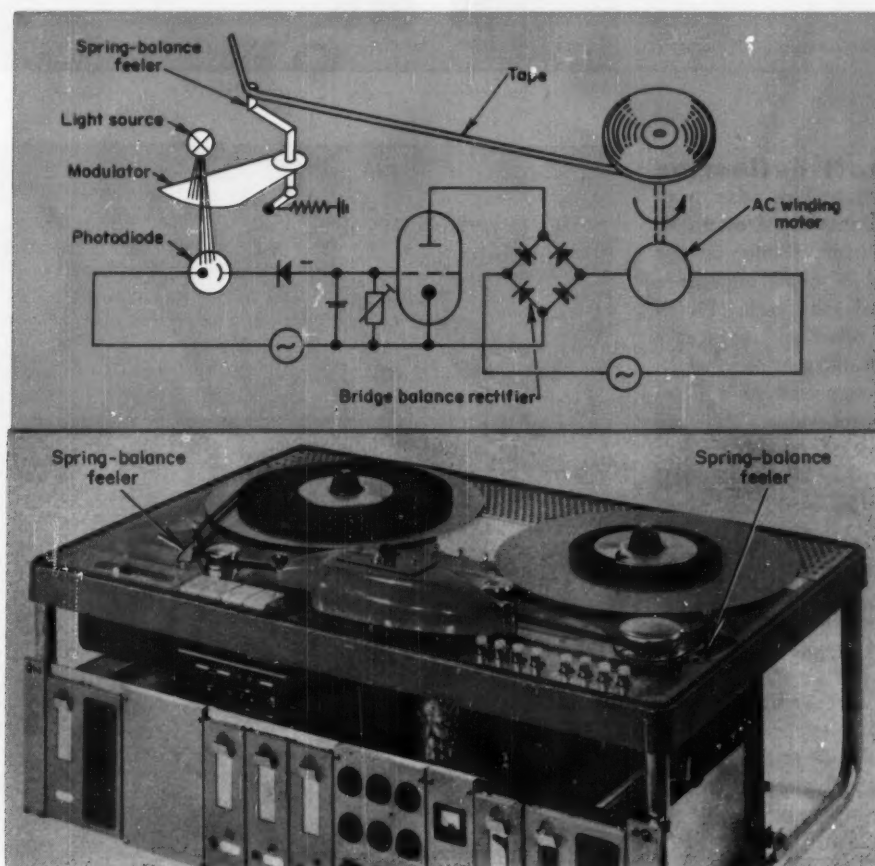
"A party seeking a right under the patent statutes may avail himself of all their provisions and the courts may not deny him the benefit of a single one."⁴

REFERENCES

1. Sperry Products Inc. v. Aluminum Co. of America, 171 F.2 901, Ohio, January 5, 1959.
2. United Shoe Machinery Co. v. O'Donnell Rubber Products Co., 84 Fed. 2d 383, Ohio, June 4, 1936.
3. Continental Paper Bag Co. v. Eastern Paper Bag Co., 210 U. S. 405, June 1, 1908.
4. Hartford-Empire Co. v. United States, 323 U. S. 386, January 8, 1945.

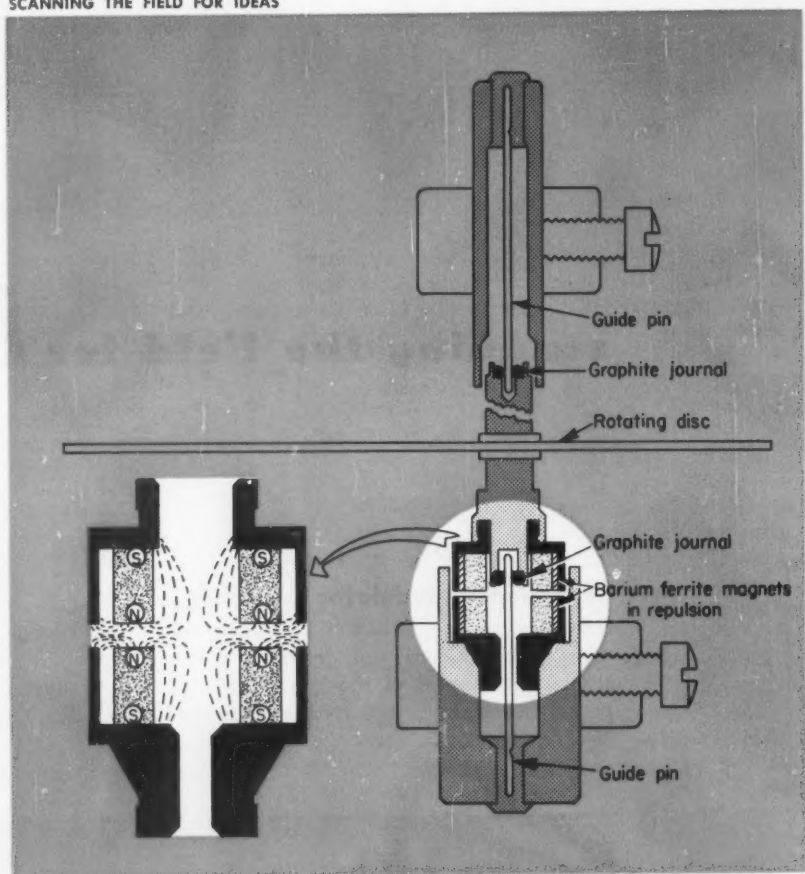
scanning the field for *ideas*

Light-beam modulator on feeler shaft controls input to tape-tension regulating device. Variation in tape tension causes change in quantity of light reaching photoelectric cell. The cell is an element of an electrical circuit which regulates the speed of the winding motor. Tape-tension control principle employed in magnetic tape recorder developed by Eberhard Vollmer, Plochingen/Neckar, Germany.



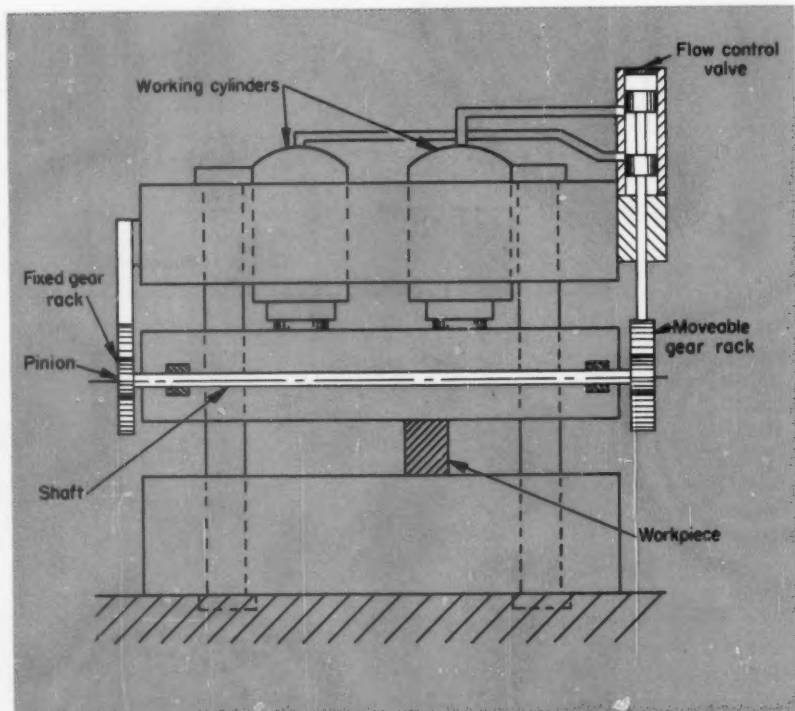
Magnetic repulsion

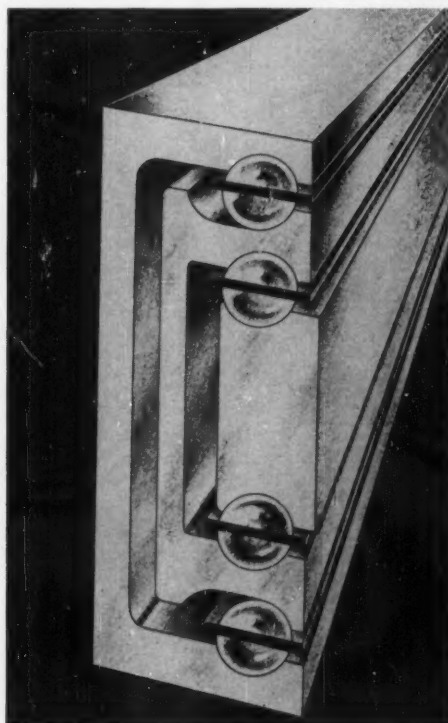
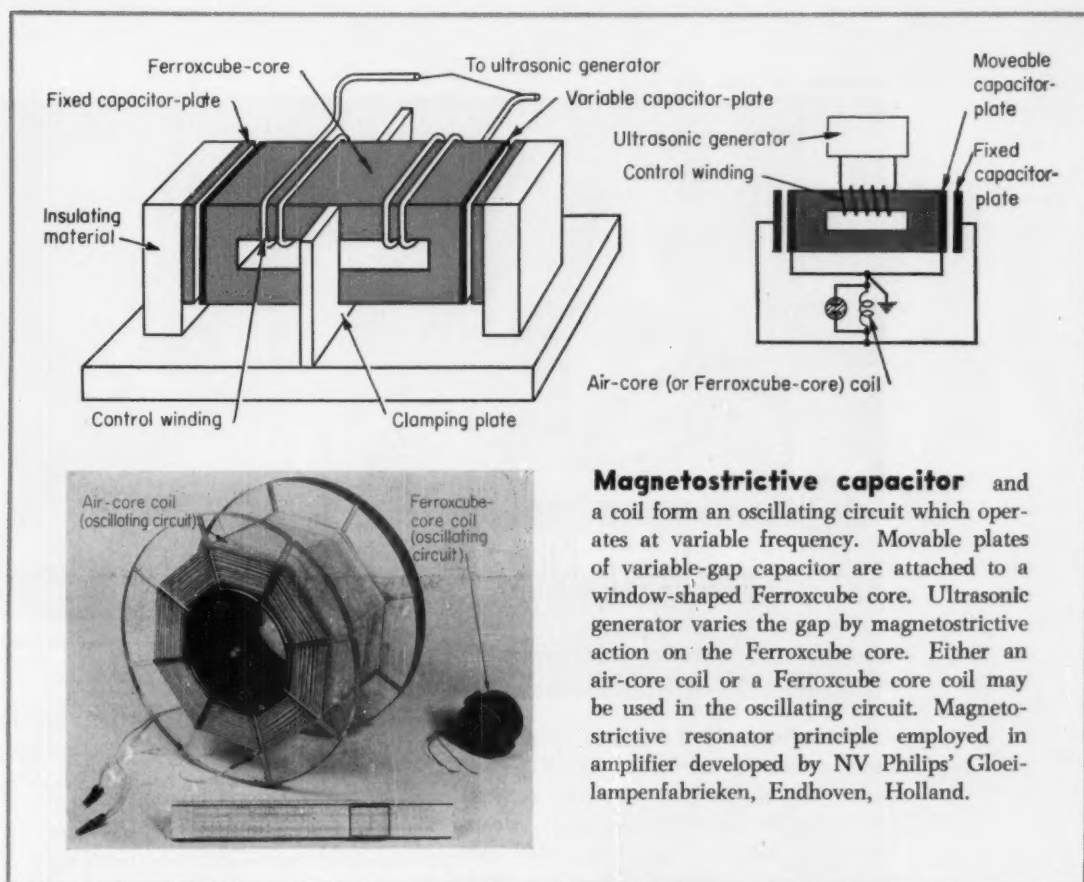
provides frictionless thrust bearing. A disc-and-shaft assembly is supported in space by two rings of ceramic permanent-magnet material, mounted so that their fields are opposed. Stationary pins within journals prevent horizontal movement of the shaft. Principle employed in meter developed by Westinghouse Electric Corp., Pittsburgh.



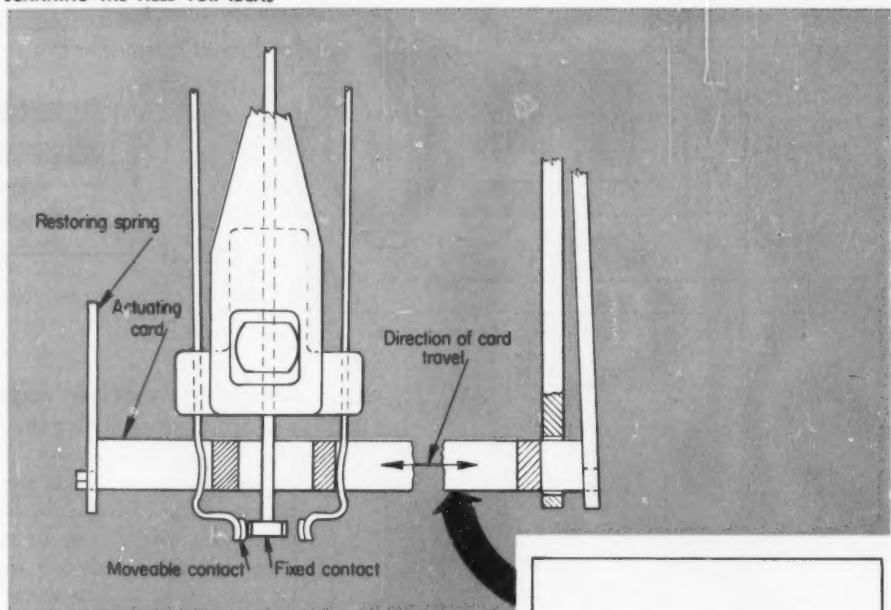
Shaft deflection

regulates flow valve to coordinate speed of paired cylinders. Pinion on one end of shaft engages a fixed gear rack. Pinion on other end engages a movable gear rack, which is connected to a flow-control valve. If piston rods extend equally, the pinions rotate equally against each rack. However, unequal extension of piston rods will deflect the shaft, displacing the movable gear rack. Thus, the flow valve is actuated to correct the unbalanced cylinder extension. Principle employed in hydraulic press developed by Swisstool AG Zurich, Switzerland.

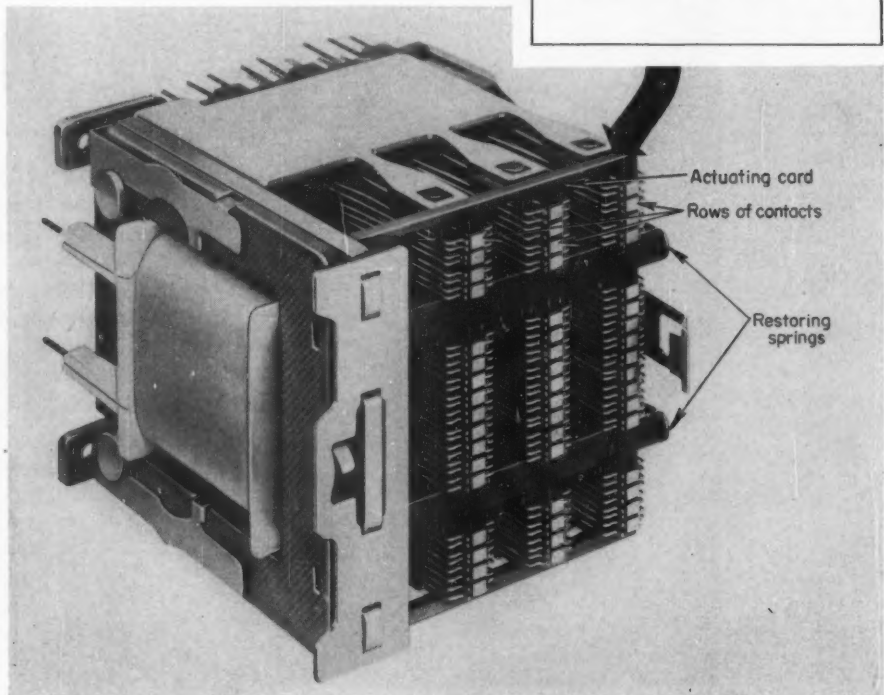
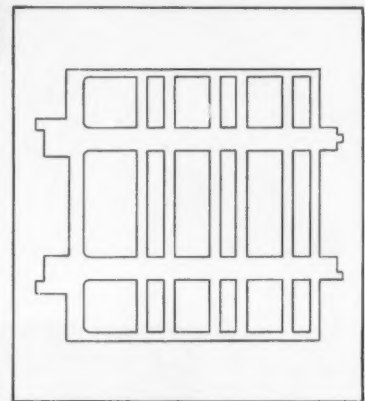


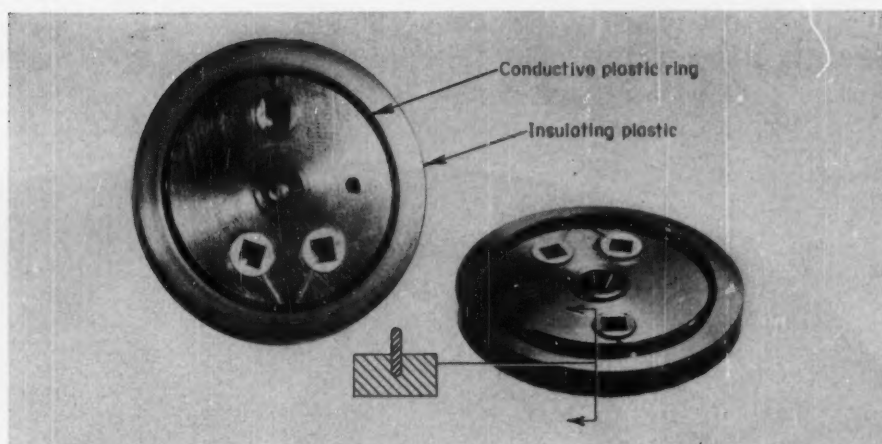


Flat-groove ball races permit lateral motion of cabinet and chassis slides. Thus, smooth action results even though cabinet and chassis are misaligned. Principle employed in slide developed by Grant Pulley and Hardware Co., West Nyack, N. Y.

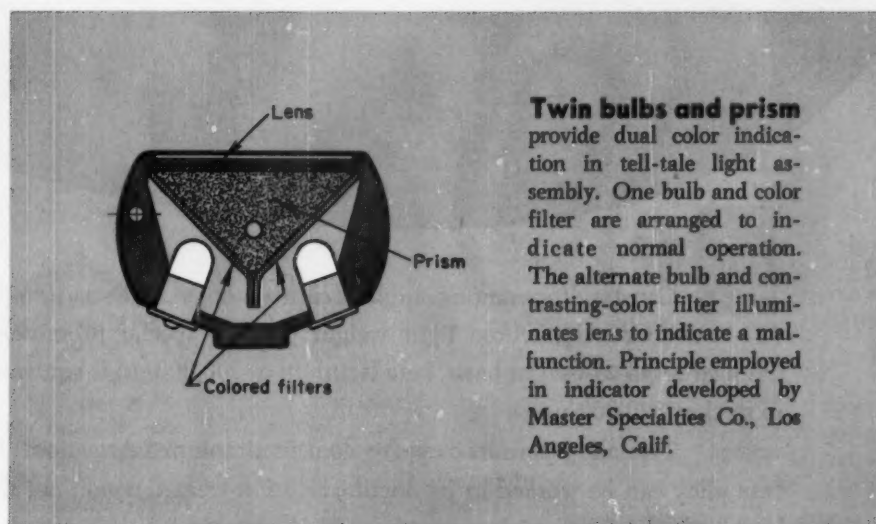
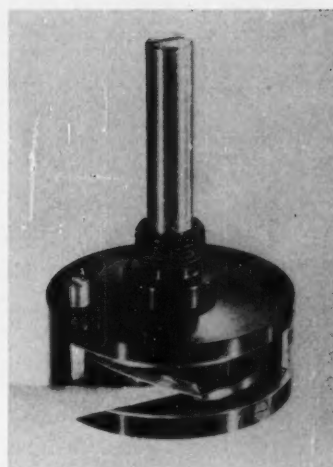


Actuating card operates multiple wire-spring contacts simultaneously. Time and sequence of operation of individual contacts can be varied by arrangement of holes in card. An armature moves the spring-loaded card to make or break movable contacts in relation to fixed contacts. Principle employed in relay developed by Automatic Electric Co., Northlake, Ill.





Conductive plastic ring provides almost friction-free surface for movable electrical contact. The high electrical-resistance plastic is molded in a base of insulating plastic to eliminate varnish and cements commonly used in wire-wound potentiometers. Principle employed in potentiometer developed by New England Instrument Co., Woonsocket, R. I.



Twin bulbs and prism provide dual color indication in tell-tale light assembly. One bulb and color filter are arranged to indicate normal operation. The alternate bulb and contrasting-color filter illuminates lens to indicate a malfunction. Principle employed in indicator developed by Master Specialties Co., Los Angeles, Calif.

design properties and fabrication characteristics of _____



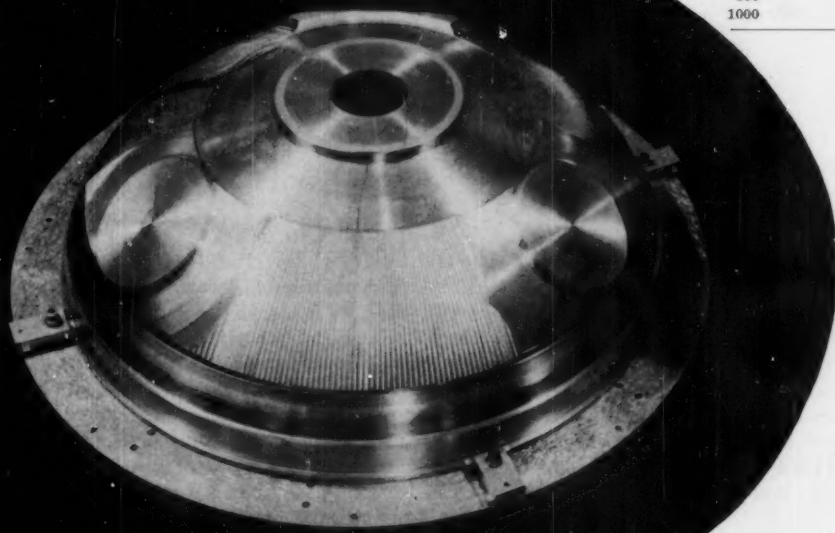
Outstanding among high-strength alloys is beta titanium (Ti-13V-11Cr-3Al), whose light weight gives it special prominence. On a strength-to-weight basis, beta titanium at 200,000 psi is equivalent to steel at 320,000 psi.

The alloy permits new freedom in titanium fabrication. The beta alloy can be worked in its ductile, solution-treated condition, then heat treated to very high strengths.

Beta Titanium

Physical Properties of Beta Titanium

Density	0.175 lb/cu in.	
Thermal Expansion (68 to 1000 F average)	5.9×10^{-6} in./in./deg F	
Specific Heat (to 200 F)	0.13 Btu/lb/deg F	
Poisson's Ratio	0.304	
Modulus of Elasticity, E , (psi)		
Temperature (F)	Solution Treated	Solution Treated and Aged
-65	14.8×10^4	16.2×10^4
70	14.7×10^4	16.0×10^4
400	14.0×10^4	15.5×10^4
600	13.2×10^4	15.0×10^4
800	12.4×10^4	14.4×10^4
1000	11.6×10^4	13.7×10^4



Rocket case end closure, forged, left; machined, above.

E. F. ERBIN

Assistant Manager
Technical Services
Titanium Metals Corp. of America
New York

COMMERCIALLY available for about two years, beta titanium alloy has been used primarily to reduce weight in high-performance airborne equipment. The sole member of the exclusive beta titanium family offers strength-to-density ratios in excess of 1 million.

Because of its desirable forming and welding characteristics, beta titanium adapts well to aircraft and missile requirements—even on-site missile fabrication can be considered. Besides these character-

istics, the alloy is also readily forged and offers high strength stability at elevated temperatures.

Metallurgy

Ti-13V-11Cr-3Al* is a titanium-base metal grade alloyed primarily with those elements which stabilize titanium's normally high-temperature beta phase to room temperature. The presence of the vanadium

*Ti-13V-11Cr-3Al has been designated by a variety of names, including VCA-beta, 13-11-3, all-beta, Ti-120VCA, and B-120VCA.

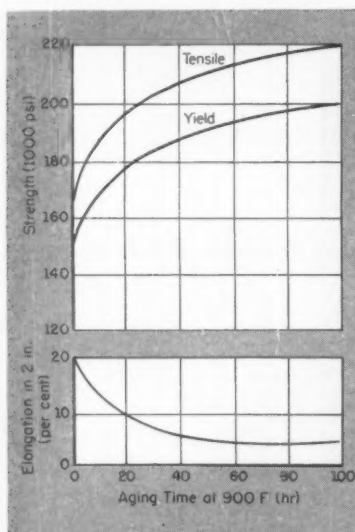


Fig. 1—Aging characteristics of annealed beta titanium mill sheet.

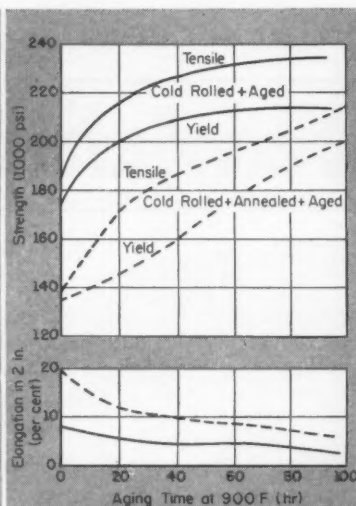


Fig. 2—Aging characteristics of cold-rolled beta titanium strip.

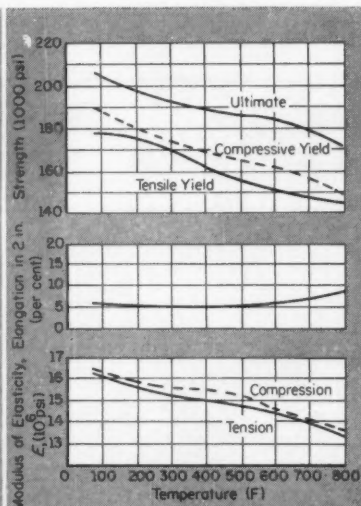


Fig. 3—Elevated-temperature properties of beta titanium. Curves show properties of 0.063 in. thick sheet, solution annealed (20 min at 1450 F), air cooled, and aged (60 hr at 900 F).

and chromium lower the beta-to-alpha transformation temperature to approximately 1325 F. Below this temperature, the beta phase normally transforms to the low-temperature equilibrium phase, alpha plus beta.

However, the alloy is so heavily beta-stabilized that the low-temperature kinetics are very sluggish; thus the alloy remains 100 per cent beta when cooled at reasonably slow rates from 1350 F to room temperature. This structure is ductile and soft despite the amount of alloy additions.

Upon reheating to temperatures over 600 F, the equilibrium alpha phase occurs by transformation of the beta. The reaction is slow below 1100 F but can be accelerated by cold working.

Between 800 and 1200 F, a secondary precipitation product, TiCr_2 , occurs. The presence of alpha and TiCr_2 in the beta matrix increases hardness and strength, and decreases ductility. Control of this precipitation mechanism achieves excellent combinations of mechanical properties in beta titanium.

Like all titanium grades, Ti-13V-11Cr-3Al is vacuum-melted to minimize potential contamination by oxygen, nitrogen, and hydrogen.

Heat Treatment

Heat-treatment procedures recommended for Ti-13V-11Cr-3Al afford a highly formable material condition which can be subsequently aged to provide a combination of high strength and good ductility. Sheet is normally purchased in the solution-treated condition, ready for fabrication and aging; aged sheet and bar are available for use where little fabrication

is required.

Material supplied in the solution-treated condition is annealed at 1425 ± 25 F for 10 to 30 min, followed by air cooling. For interstage annealing of fabricated sheet parts, a temperature of 1375 ± 25 F is recommended. If intermediate anneals are used, or if a final stress relief anneal is employed following fabrication, the use of a temperature above 1400 F may degrade final aged properties.

Solution-treated material may be aged to optimum combinations of strength and ductility in 10 to 100 hr at temperatures of 800 to 900 F. Fig. 1 and 2 show typical aging curves at 900 F for solution-treated sheet and cold-rolled strip.

Forgings of beta titanium having sections less than 3 in. thick show optimum properties when aged directly after air cooling from the forging operation without an intermediate solution treatment.

If a stress-relief anneal is required after forming, a cycle of 15 min at 950 to 1050 F is recommended.

Cleaning of Parts: Material to be heat treated should be cleaned of all hydrocarbons and carbonaceous matter. Residuals from chlorine-containing cleaners should be removed prior to heat treatment. A light acid pickle is recommended for final cleaning, with proper care to avoid further chloride contamination.

Heat-Treat Atmospheres: Beta titanium is contaminated in air above 800 F. Although air contamination can be safely removed by descaling and pickling, the use of inert atmospheres during heat treatment should be considered. Hydrogen contamination from furnace atmospheres is to be avoided.

Table 1—Mechanical Properties of Beta Titanium

	Sheet and Strip			Foil*	Bar, Billet, Forging and Fastener Stock	
	Solution Treated	Aged	Cold Rolled and Aged		Solution Treated	Aged
Yield Strength, 0.2 per cent (1000 psi)	120	170	200	220	120	170
Ultimate Tensile Strength (1000 psi)	125	190	220	230	125	185
Elongation in 2 in. (per cent)	10	4† 3‡	3	2	...	...
Elongation in 4 diam (per cent)	...	...	...	...	10	4

*Under 0.008 in.; †Above 0.020 in.; ‡0.020 in. and less.

Table 2—Longitudinal and Transverse Properties (Large Bar and Billet)

Thickness (in.)	Direction	Yield Strength, 0.2 per cent (1000 psi)	Ultimate Tensile Strength (1000 psi)	Elongation in 4 diam (per cent)
4	L	179	192	6
	T	182	195	6
6	L	174	184	7
	T	174	186	5
8	L	173	185	7
	T	176	189	4

Table 3—Elevated-Temperature Tensile Properties*

Test Temperature (F)	Yield Strength 0.2 per cent (1000 psi)	Ultimate Tensile Strength (1000 psi)	Elongation in 2 in. (per cent)
70	131.0	133.5	21
200	118.5	125.0	21
400	111.0	122.0	23
600	97.0	115.0	23
800	104.0	123.5	18
1000	95.0	101.0	34

*Sheet and bar, in solution-treated condition.

Descaling and Pickling: The attention given surface-cleaning procedures after interstage or final annealing, stress relieving, or final aging will influence both the formability and the final mechanical properties of beta titanium. Both the surface scale and the intermediate dissolved-oxygen layer must be removed; the extent of each will vary with the temperature and time of prior exposure. Hydrogen pickup in the cleaning media should be avoided.

Corrosion Resistance

Beta titanium, in either the solution-treated or aged condition, is inert to sea water, salt and other natural environments, oxidizing media, inhibited reducing acids, alkalis, and metal chlorides at ambient temperatures. In salt spray tests, aged beta titanium displays no pitting, general corrosion, or degradation in mechanical properties; thus, the alloy provides permanent corrosion immunity without the need for protective coatings.

Mechanical Properties

Although its metallurgical and mechanical characteristics had been determined several years ago, beta titanium was not introduced to the commercial market until mid-1958.† Development was accelerated when airborne systems advanced to a point that required the alloy's properties, Table 1.

†"Formable Titanium," MACHINE DESIGN, Vol. 30, No. 14, July 10, 1958, pp. 12, 14.

Sheet, Strip, Plate and Foil: Sheet and plate material is available in three conditions of heat treatment: 1. Solution treated (ST). 2. Solution treated and aged (STA). 3. Solution treated and cold rolled (STCR).

Size availability is:	Thickness (in.)	Size Range (in.)
	0.010-0.025	36 × 96
	0.026-0.039	36 × 120
	0.040 +	48 × 120
		or 36 × 144
	0.002 +	6 × coil

Bar, Billet, Forging Stock, and Wire: Forging billet is available in sizes up to 20 in. diam. Bar stock and large billet is supplied either in the annealed condition or fully aged. Longitudinal and transverse properties of 4 to 8-in. thick billets are shown in Table 2. Rivet wire and fastener stock are available either in the ST or STA condition. Welding-wire diameters down to 0.020 in. are standard. High-strength wire as small as 0.002 in. diam is currently being developed.

High-Temperature Properties

Tensile properties of beta titanium solution-treated sheet and bar at elevated temperatures are presented in Table 3; properties of aged sheet and bar are shown in Fig. 3. Fig. 4 and 5 show stress-strain curves at temperatures to 800 F.

The tensile properties to 600 F of cold-worked and aged sheet and strip, are shown in Fig. 6. On

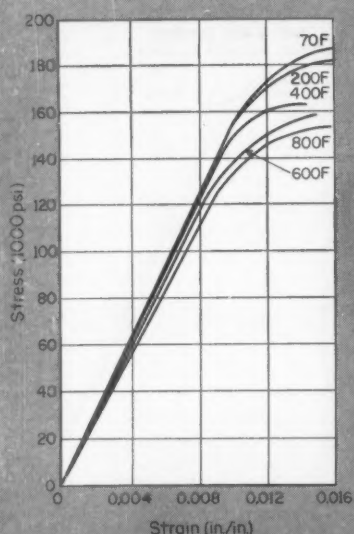


Fig. 4—Typical tensile stress-strain curves for aged beta-titanium.

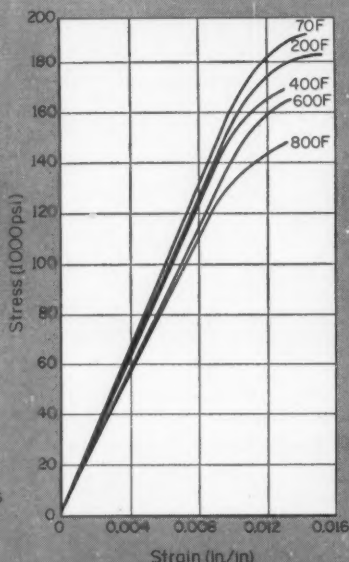


Fig. 5—Typical compressive stress-strain curves for aged beta-titanium.

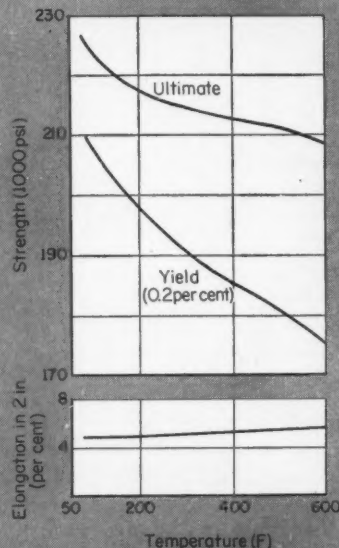


Fig. 6—Effect of temperature on the tensile properties of beta titanium alloys, cold-rolled, aged (900 F for 10 hr), and air cooled.

a strength-to-weight basis, Fig. 7, beta titanium offers advantages under tensile loading conditions over all structural sheet materials including aluminum and steel alloys.

Elevated-temperature shear-strength properties of beta titanium are shown in Table 4. The properties are those of nominal $\frac{1}{2}$ in. diam rounds, machined to 0.375 in. diam.

The ability of a structural member to retain its initial strength and ductility after prolonged exposure under stress at elevated temperatures, Table 5, is an important consideration in airframe design. Stability data were obtained by tensile testing aged material at room temperature prior to and after exposure to stress and temperature. Serious losses of strength or ductility are indicative of instability.

Above 500 F, beta titanium continues to age during prolonged exposure. An increase in yield strength also results after such exposures. This is not undesirable unless the corresponding ductility values drop to an unacceptable level.

Notched-Tensile Characteristics

Beta-titanium alloy, in the solution-treated condition is extremely notch tough. The notched-unnotched strength ratio for sheet and bar at moderate to severe stress-concentration factors exceeds unity. Load-carrying ability of the alloy in this condition, even in the presence of sharp fatigue cracks, is excellent, Fig. 8.

The method of initiating the crack consists of subjecting a 4-in. wide panel, with a hole drilled in

its center, to axial fatigue loading. The crack, moving in two directions from the hole, is propagated to the desired length. The panel is then tested statically in tension.

The notched-tensile properties of aged beta titanium are shown in Table 6. At yield-strength levels approaching 185,000 psi, the alloy in this condition becomes sensitive to even moderate notches, and the notched-unnotched strength ratio of sheet products falls below unity.

Low-Temperature Characteristics

The notched Charpy impact strength, as well as tensile properties, of beta titanium go through a rapid transition below room temperature. Impact strength of aged bar at -65 F is only 50 per cent of its strength at 70 F.

Notched tensile properties, as well as conventional tensile properties of aged material are seriously impaired at temperature below -100 F. However, solution-treated material retains toughness to at least -320 F, Table 7, and can be considered for cryogenic applications.

Welding

The beta alloy is readily weldable. Its high base-metal strength can be combined with strong, ductile weldments into efficient, lightweight assemblies.

Fusion Welding: As is characteristic of all titanium metal grades, the weld and heat-affected zones of

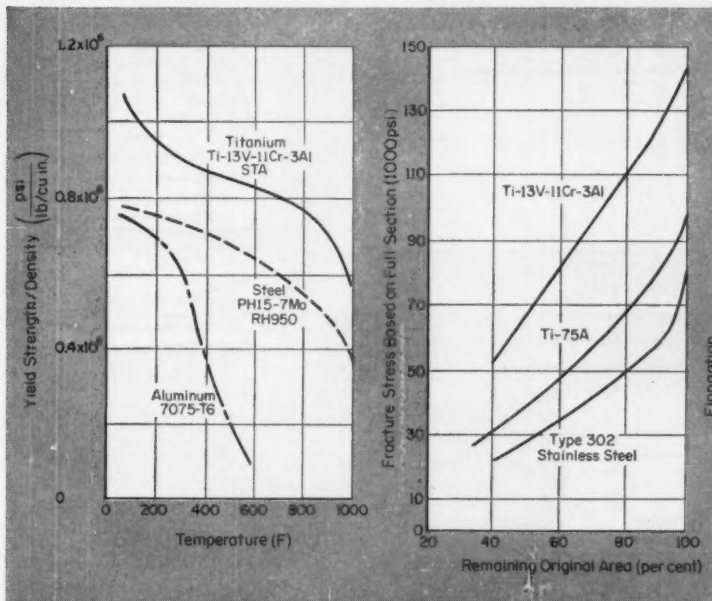


Fig. 7—Comparison at elevated temperatures of beta-titanium alloy and high-strength steel and aluminum alloys. Comparison is made on basis of 0.2 per cent yield strength to density ratio of the alloys.

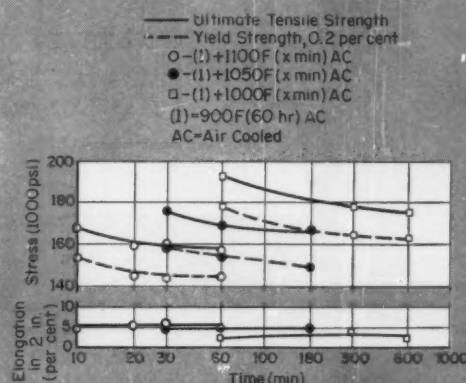


Fig. 9—Effect of postweld duplex-aging treatments on tensile properties of fusion-welded 0.062-in. beta titanium. Welds are parallel to axis of loading.

beta titanium require shielding by a blanket of inert gas (helium or argon) to prevent contamination by trace impurities from the atmosphere—specifically, oxygen, hydrogen, and nitrogen. The alloy is fusion welded by inert-gas shielded techniques using the nonconsumable (thoriated tungsten) or consumable (sigma) electrode process.

Heat Treatment	Temperature (F)	Shear Strength (1000 psi)
1400 F (30 min), AC ^a	—65	121.0
	75	110.0
	200	104.0
	400	97.5
	600	93.6
	800	86.5
1400 F (30 min), AC, 900 F (48 hr), AC	—65	139.0
	75	130.0
	200	121.0
	400	117.0
	600	111.0
	800	102.0

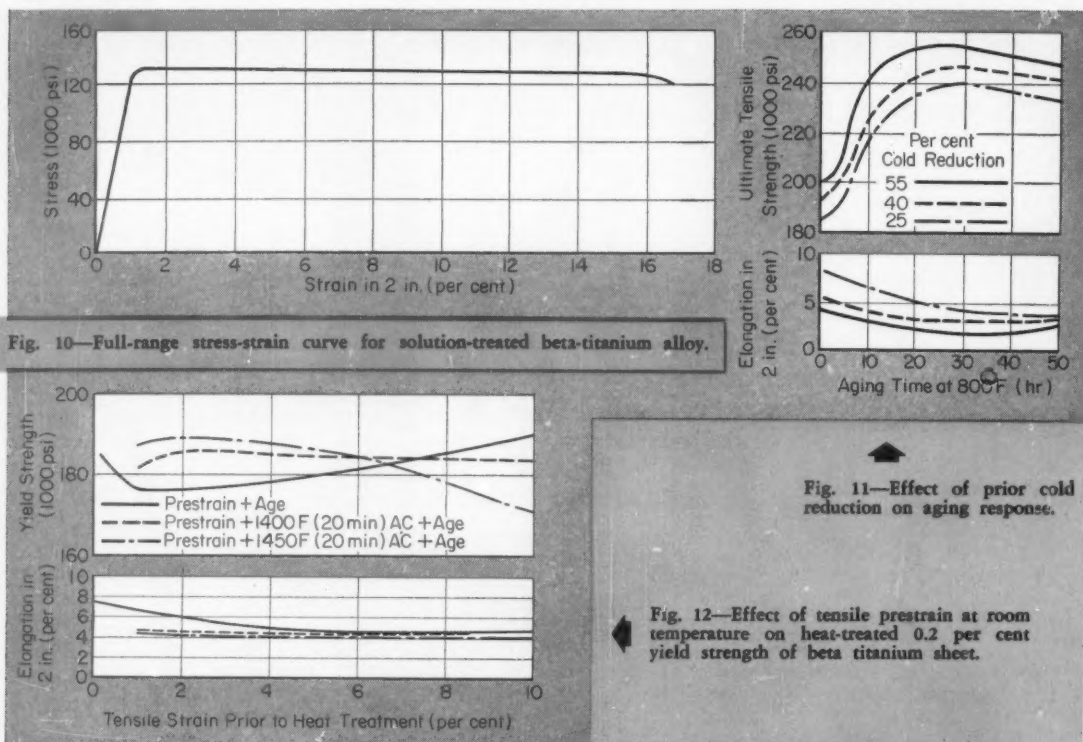
*AC = Air Cooled

Stability Exposure Conditions			— Properties After Exposure* —		
Temperature (F)	Stress (1000 psi)	Time (hr)	Ultimate Tensile Strength (1000 psi)	Yield Strength, 0.2 per cent in 2 in. (1000 psi)	Elongation in 2 in. (per cent)
No Exposure			202	174	6
500	140	500	201	185	6
500	160	500	200	191	6
500	160	1000	203	195	4
600	140	500	203	188	4
600	140	1000	205	186	5
700	100	150	210	190	5
700	100	250	206	188	3
700	100	500	208	198	5
700	80	500	209	197	4
700	100	1000	219	208	2†
700	100	1000	219	192	1†
800	80	150	218	205	4
800	50	500	212	201	1†

*Tensile-tested without surface conditioning after exposure.
†Indicative of metallurgical instability.

Ultimate Tensile Strength (1000 psi)	Yield Strength, 0.3 per cent (1000 psi)	Elongation in 2 in. (per cent)	Notched Strength (1000 psi)	Notched-to-Unnotched Strength Ratio
Sheet				
204	185	5	184	0.90
206	187	6	183	0.89
205	186	5	189	0.92
Bar				
187	180	4	196	1.06
202	195	5	211	1.03

*Stress-concentration factor, $K_t = 4$.



metal is used for welding the beta alloy.

In the as-welded condition, tensile and bend ductility are good, Table 8, and the welds have high notch toughness and intermediate strength at room temperature. Stress relieving or annealing of fusion welds is permissible. Table 9 indicates the changes in properties—mainly ductility—resulting from postweld annealing.

AGING OF WELDMENTS: Although weldments of beta-titanium alloy age at essentially the same rate as the base metal, weld ductility drops sharply with strength increase. Single aging cycles are only used successfully on weldments when postweld mechanical plastic working is employed.

Duplex-aging treatments produce good strength and ductility combinations, Fig. 9, and provide the added advantage of imparting elevated-temperature stability to the weldment. Because of their metastable nature, beta-titanium weldments in the as-welded condition become embrittled after prolonged exposure to elevated temperatures. They are stabilized to at least 600 F by duplex aging.

ROLL PLANISHING: Mechanically cold-working the weld by roll planishing permits use of normal aging cycles to produce high strengths and acceptable ductility in weldments. The effect of a 25 per cent cold reduction of weld-bead thickness prior to normal aging is shown in Table 10.

NOTCHED-TENSILE PROPERTIES: In the as-welded condition the weld is notch-tough. However, the heat-affected zone of the fusion weld is more sensitive than the weld itself. Duplex aging treatments result in moderate notch toughness.

Resistance Welding: The beta alloy has excellent resistance-welding characteristics. Spot and seam welding result in high-strength, ductile joints. Shear-strength values are slightly higher than those obtained with commercially pure titanium, and cross-tension strength is considerably higher. A tension-to-shear ratio of about 0.4 is obtained in spot-welded joints.

Exposure of spot welds to temperatures above 400 F results in a loss of cross-tension strength due to the metallurgical instability of the weld. Above 500 F this loss becomes prohibitive.

Fabrication

Soft and ductile in the solution-treated condition, beta titanium is the most formable, high-strength titanium alloy available.

Sheet Fabrication: Beta titanium lends itself to virtually all sheet-metal fabrication processes because of its high degree of total and local tensile ductility, Fig. 10. It possesses good bend ductility and resistance to cracking upon bending, although a marked orange-peel effect is produced on the deformed surface. Deep draws up to 40 per cent reduction are achieved without annealing. Beta titanium is suitable for cold rubber-overlay hydropress forming followed by hot sizing if necessary. Hot sizing or creep forming can be done at 900 F as part of the aging cycle.

Plate and sheet, either annealed or with a high degree of cold work introduced, can be roll formed

Table 7—Effect of Low Temperature on Notched Tensile Properties

Temperature (F)	Unnotched			Notched*	
	Ultimate Tensile Strength (1000 psi)	Yield Strength, 0.2 per cent (1000 psi)	Elongation (per cent)	Tensile Strength (1000 psi)	Notched-to- Unnotched Strength Ratio
Solution Treated					
70	136.1	129.1	21	176.1	1.29
-65	167.5	162.4	18	218.9	1.31
-320	276.5	266.7	7	276.8	1.00
Aged					
70	207.4	176.0	6	188.8	0.91
-65	223.8	217.2	3	206.0	0.92
-320	....	Brittle	..	178.4	...

*Stress-concentration factor, $K_t = 4$

into cylindrical sections for welding.

The alloy plastically deforms readily at room temperature without fracturing under either compression (rolling) or shear (shear spinning) loading. Forged rings or rolled and welded rings have been utilized as preforms for the shear-spinning process. Aging response, Fig. 11, is considerably enhanced by cold work.

PRESTRAIN DEFORMATION: The effect of straining solution-treated material during sheet fabrication upon subsequent aging response is shown in Fig. 12. Beyond 8 per cent tensile deformation, final aged strengths are higher than in nonprestrained material.

Tensile elongation of the aged condition decreases as prestrain increases. Loss of aged elongation is slight at small amounts of prestrain, and at 10 per cent prestrain, aged material loses about 25 per cent ductility compared to nonprestrained material.

INTERSTAGE ANNEALING: The use of temperatures above 1400 F for an interstage or final anneal can result in a loss of final aged properties, Fig. 12. At small amounts of prestrain, annealing at 1450 F has an advantage, but after larger prestrain treatment, a maximum of 1400 F is recommended.

Machining: The beta alloy is best machined in the aged condition. Although feeds for beta titanium are the same as for other titanium alloys, cutting speeds for the new alloy are recommended at 35 to 50 per cent less. An abundance of water-soluble oil coolant is required.

Forging: Because of the high hot strength of its alloy composition, the beta alloy requires more power in forging than do commercially pure or other alloy-titanium grades. With sufficient equipment capacity, either open or closed-die forgings are easily made with beta titanium. It can be upset or redrawn to a satisfactory metallographic structure by a number of single, double, or triple forging cycles. The use of forging temperatures above the beta transus (1325 F) is not prohibitive as it is with alpha-beta titanium alloys; temperatures as high as 1850 F can be used when followed by substantial reductions.

Lower finishing temperatures prevent excessive grain growth and are conducive to grain refinement during forging. Grain growth is rapid above 1550 F if plastic deformation is not introduced concurrent with heating. Preheating to a lower temperature, followed by a rapid heating at the forging tempera-

Table 8—Properties of As-Welded Sheet and Plate

Test Direction	Tensile Properties			
	Ultimate Tensile Strength (1000 psi)	Yield Strength, 0.2 per cent (1000 psi)	Elongation	
			In 2 in. (per cent)	In 0.5 in. (per cent)
Parallel to weld				
Sheet*	141.4	124.0	17	..
Plate†	131.4	124.2	14	..
Transverse to weld				
Sheet*	141.8	135.1	..	16
Plate†	140.5	134.7	..	15

Bend Ductility

Direction, Weld Axis to Bend Axis

Bend Radius, 90 degrees

Parallel

3.5 × thickness

Transverse

4.0 × thickness

*0.063 in. thick.

†0.250 in. thick plate; Double-Pass Welds.

Table 9—Tensile Properties of Welded Sheet

Test Direction to Weld Axis	Ultimate Tensile Strength (1000 psi)	Yield Strength, 0.2 per cent (1000 psi)	Elongation	
			In 2 in. (per cent)	In 0.5 in. (per cent)
Welded + 1100 F (15 min)				
Transverse	141.6	136.9	..	15
Parallel	134.1	126.9	17	..
Welded + 1450 F (15 min)				
Transverse	140.5	135.3	..	8
Parallel	133.8	126.8	7	..

Table 10—Effect of Cold Work on Properties of Aged Weldments

Condition	Ultimate Tensile Strength (1000 psi)	Yield Strength, 0.2 per cent (1000 psi)	Elongation in 0.5 in. (per cent)
As-Welded	141	135	16
Weld + 900 F (60 hr), AC	..	Brittle	..
Weld + Cold Roll + 900 F (60 hr), AC	206	201	3
Weld + Cold Roll + Duplex Age	187	178	6

ture is recommended.

High-temperature heating or quenching of beta-titanium forgings is unnecessary; only a simple age is required. The forging should be cooled to room temperature within one hour from the forging temperature. Heat treatment is accomplished by simple aging at 900 F for periods of 5 to 48 hr, dependent upon the particular forging.

Full-scale motor cases of beta alloy have been built and tested, with cases bursting at equivalent hoop stresses in excess of 200,000 psi.

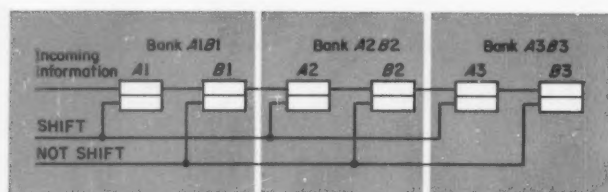


Fig. 1—Basic simultaneous shift-register system.

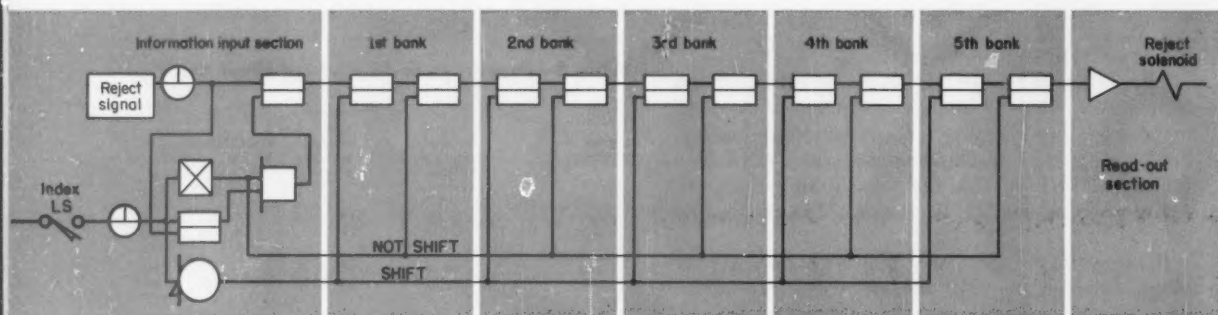


Fig. 2—Single-channel, five-bank shift register used to reject faulty parts from a machine.

Table 1—Static-Control Logic Symbols

	Name	Function
	Two-input AND	Produces an output when both inputs are present.
	Four-input AND	Produces an output when all inputs are present.
	Three-input OR	Produces an output when any one or more inputs are present.
	Two-input NOT	Produces an output when neither input is present.
	Retentive MEMORY	Produces an output when a momentary signal is received by the on input. The output remains until a momentary signal is received by the off input. If power is interrupted and later restored, the retentive MEMORY will retain the output condition which existed when power was interrupted. If maintained signals are present on both off and on inputs, the output will comply with the input that was impressed first.
	Original input	Reduces standard control voltage to a signal of proper amplitude for use in the logic portion of the system. (A signal converter.)
	Power amplifier	Amplifies a logic signal. (A signal converter.)
	Shift-register unit	Represents a number of logic elements that comprise one bank of one channel of a shift register.

WHEN controls are required to initiate some action on a particular part at a specific time, special circuits known as shift registers can often provide a practical approach to the problem. Such circuits are especially useful for equipment designed for material handling or automatic warehousing, or for certain machine tool or test-instrument operations.

Static-control shift registers can be a valuable tool in circuit design. The static elements used in these circuits feature extreme reliability, long life, completely retentive memory, and the ability to operate in almost any environment. Consequently, the circuits offer these same advantages plus maximum flexibility, ease of operation and maintenance, and reasonable initial cost. Symbols commonly used in static-control circuits, and the logic functions they represent, are given in Table 1.

Basic Types

Of the two basic types of shift registers, the simpler one is the simultaneous shift register. It can be used, for example, where a material-handling de-

For controlling sequential, random, or evenly spaced operations:

STATIC-CONTROL SHIFT REGISTERS

E. L. RUDISILL

Application Engineer
General Purpose Control Dept.
General Electric Co.
Bloomington, Ill.

vice has equal spacing between storage points for the parts in process, and where all the parts move at the same speed with relation to each other. An example of this application is a conveyor on which the objects to be conveyed ride between equally spaced lugs.

The other basic shift-register type is a storage shift register, which can handle information for parts that are random-spaced and where relative speed between parts is not constant. This method can be used, for instance, to direct material which is placed on pallets and transported by a gravity roller conveyor to various storage take-off points along the way.

A shift-register unit is a portion of control circuitry comprised of several static elements which can perform logic functions. Consequently, a shift-register unit has the ability to receive and store information. It also has the ability to transfer or shift information, upon command, to a succeeding shift-register unit connected in tandem.

A single horizontal line of shift-register units in tandem is called a channel. A shift-register bank is a vertical row of shift-register units comprised of

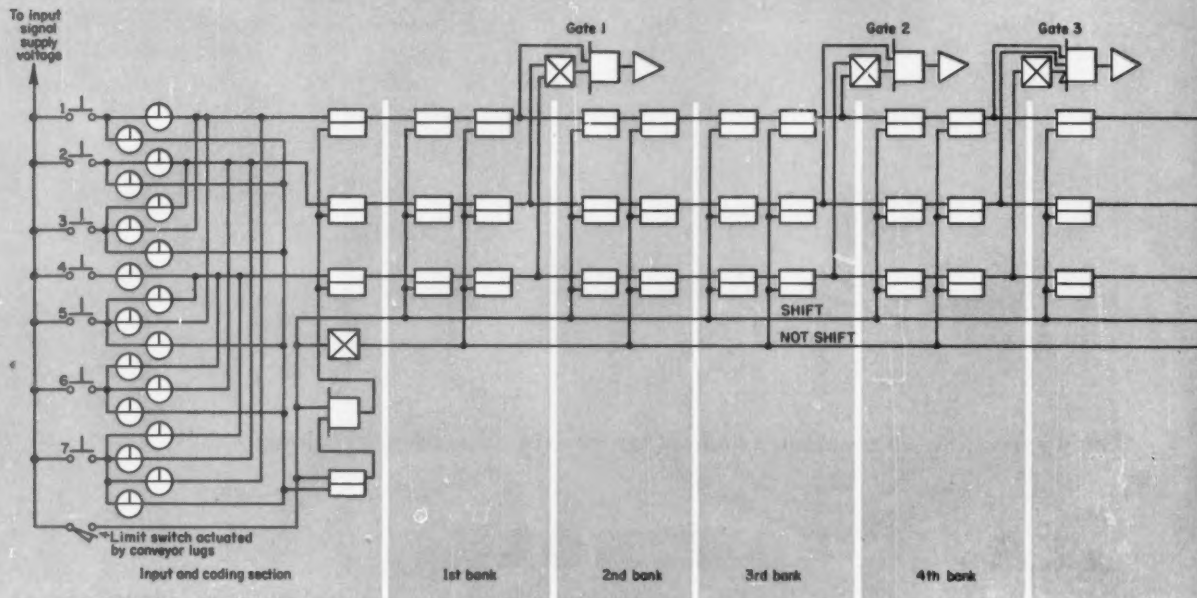
These logic-function devices enable a control to remember the identity and destination of a piece of material. Typical control circuits can be adapted to machining or testing processes as well as to automatic conveyor systems.

one unit from each channel. The number of banks of shift registers in tandem is determined by the maximum number of bits of information that have to be stored at any one time. The number of channels depends on the maximum complexity of a bit of information. More than one channel must be used to store and transmit code numbers higher than one. The system of binary coding will be described later in an example.

Simultaneous Shift Register

A simple shift-register unit may contain two MEMORY elements such as A1 and B1 in Fig. 1. The B1 MEMORY holds information for read-out or transfer to the next succeeding unit. The A1 MEM-

STATIC-CONTROL SHIFT REGISTERS



ORY receives an incoming signal and holds it while information in the B1 MEMORY is shifted forward to the A2 MEMORY in the following bank.

The shifting process is accomplished by two signals, SHIFT and NOT SHIFT. Usually, a limit switch or photoelectric cell produces both signals—a closed switch producing a SHIFT signal, an open switch producing a NOT SHIFT signal. When an information signal is in unit A1B1, MEMORIES A1, B1, and A2 are all on, even though MEMORY B1 also has an off signal applied to it. MEMORY B1, however, maintains its output because its on signal was applied before the NOT SHIFT, or off, signal. Thus, B1 will keep its output until MEMORY A1 is turned off by a SHIFT signal.

If unit A1B1 receives no new incoming information, and the shift-initiating limit switch or photocell is actuated to its closed position, MEMORY A1 turns off. MEMORIES B1 and A2 remain on, and B2 turns on, but A3 is held off by the SHIFT signal. When the shift limit switch reopens, MEMORY A3 loses its off input and is turned on by MEMORY B2. At the same time, MEMORY B3 receives a NOT SHIFT signal which holds it off until the next time the shift limit switch is actuated. The simultaneous shift register, therefore, notches all its signals forward one bank each time the shift switch is actuated.

Application Circuitry: Suppose, for example, that parts are inspected at a given station on an indexing table, but that rejection of faulty parts is not practical until five indexes later. The control is then required to remember the status of the five

parts in process between the inspection station and the reject station. Therefore, five shift-register banks will be needed. Because the only information that has to be shifted is a signal for a faulty part to be rejected, only one channel is required. The circuit shown in Fig. 2 will perform the required function.

Only two MEMORIES are used for each shift-register unit in Fig. 2—one for information storage and read-out, the other for incoming information storage while information already in the bank is shifted out. Also shown are the information-input, SHIFT, and NOT SHIFT circuitry. Information is put into the shift-register unit if a faulty part causes a momentary closure of the inspection device contact. Information is shifted one bank at a time by a momentary closure of the index limit switch. When the table has indexed five times after detection of a faulty part, the output signal enters an amplifier, the amplifier produces a power output that actuates a solenoid, and the part is rejected.

A more complex application of the basic simultaneous shift register includes coding and decoding for read-out. A representative example is a conveyor system in which material may be removed at various locations. A schematic diagram of the basic control circuit is shown in Fig. 3.

The conveyor, as required for this type of control, has equally spaced lugs. If the conveyor has space for a maximum of nine packages, nine banks of shift-register units will be needed. Seven take-off conveyor gates are selected and located as indicated in Fig. 3. Note that the gates can be spaced irregularly along the equal increments required on the conveyor. In this case, the second and seventh banks have no

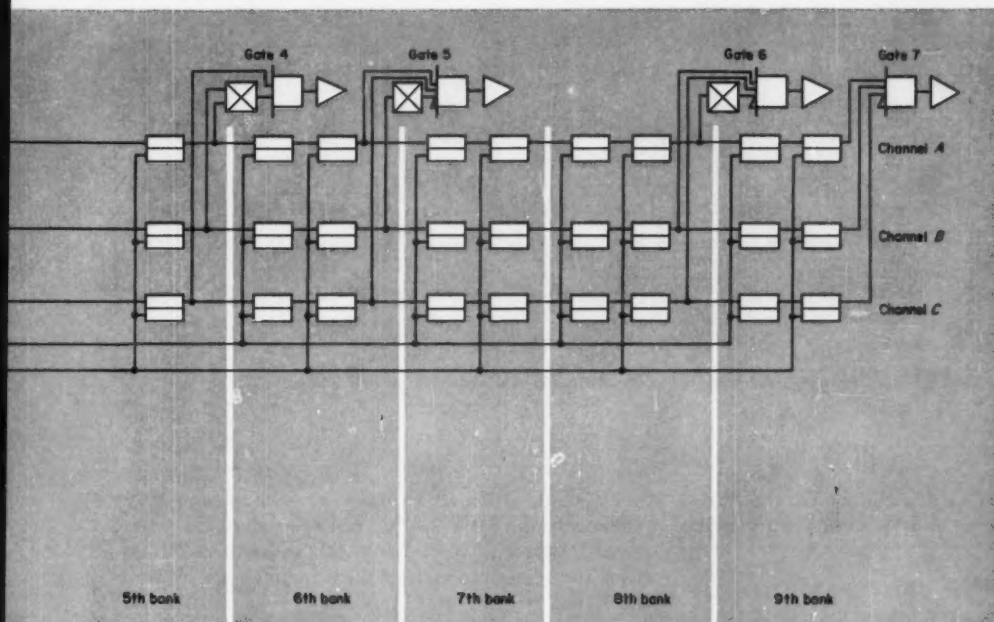


Fig. 3—Typical three-channel, nine-bank shift register for use with a conveyor having seven exits. Because three-input AND elements are not manufactured, a four-input AND is used by driving two inputs with the same signal. This arrangement will be noted in the circuits for gates 3, 5, 6, and 7.

take-off gates.

The seven take-off gates require three channels if binary coding is used. An operator or photoelectric reader selects the destination of each piece of material as it passes through a selection zone. The shift-register control then actuates the necessary transfer devices to divert the material when it reaches its selected storage conveyor.

By coding the conveyor nearest to the selection zone with the highest number, the channels can be tapered to effect a significant savings. Then, only

the channels actually required are kept as the signal moves down the register. An abbreviated schematic for a system of this type is shown in Fig. 4. Here, a read-out control is required to decode the binary signals at each take-off point.

Precautions must be taken to avoid erroneous read-out possibilities with the binary code. For instance, a read-out at Gate 7 in Fig. 4 requires signals from Channels A, AND B, AND C. To prevent a simultaneous read-out at Gate 6, read-out information for Gate 6 is changed to require signals from Channels

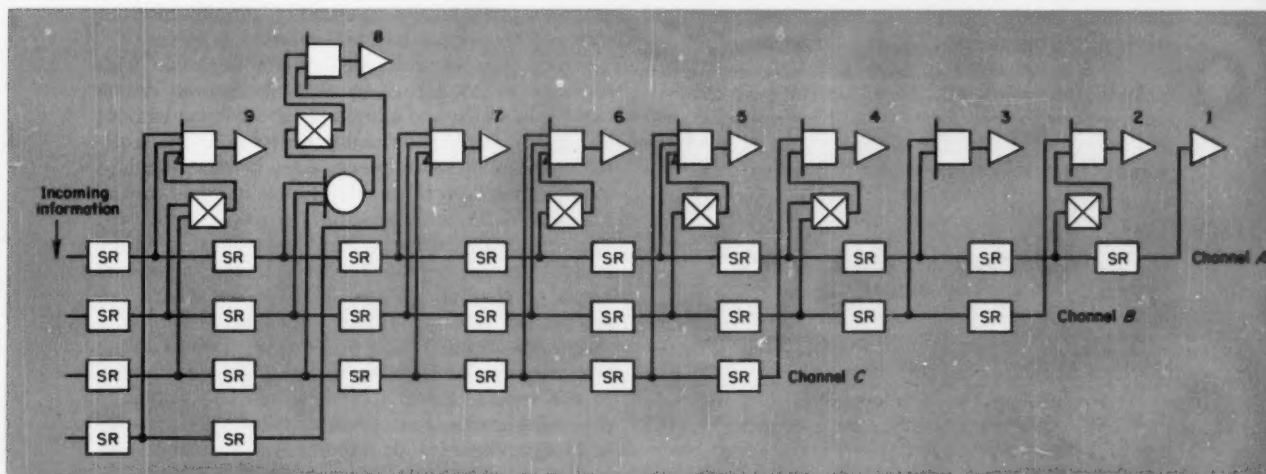


Fig. 4—Abbreviated four-channel, nine-bank tapered shift register.

STATIC-CONTROL SHIFT REGISTERS

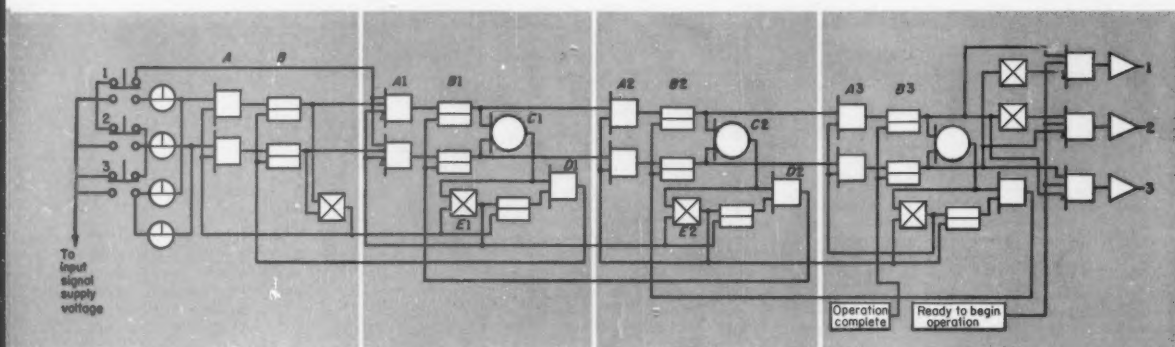


Fig. 5—Two-channel, four-bank storage shift register with one shift-out point and read-out section.

B, AND C, AND NOT A. On the whole, the read-out logic in both Fig. 3 and 4 is straightforward.

Storage Shift Register

The storage shift register handles its information quite differently than the simultaneous shift register. Instead of progressing one bank at a time, a signal put into a storage register immediately proceeds down the register, bank after bank, until it reaches either a shift-out point or a point which is blocked because of information already in it. If the point is blocked by previous information, the new information is held at this point until a shift-out signal is received. At this time, the signal in the last bank is shifted out to do its indicated work, and all the signals waiting in preceding banks go forward one bank to wait their turn to be shifted out.

The shift-out signal source is located at a point of action. As a result, information progressing down the register is held at this point of action until the physical material to which the signal pertains also arrives at this point. When the material is in position, the information signal is either read out or put into another block of storage-register units whence it proceeds to the next point of action.

Application Circuitry: Basic circuitry for a storage shift register is shown in Fig. 5. New operation information can enter only when unit A1B1 is clear, because E1 produces an output only when this con-

dition exists. Then, if B1 receives a signal and the previous bank, Bank AB, has not been reset, D1 produces a signal to reset Bank AB. If Bank A2B2 is clear, the signal proceeds in the same manner. When the signal reaches unit A3B3, it is held until it is ready to be used. Then the signal is read out. When the operation is complete, a signal to that effect is used to reset the B3 MEMORY bank, thus clearing that bank for the next bit of incoming operation information.

System Advantages

In addition to the different manner in which a signal proceeds down each shift register, one other basic difference occurs in the handling of a zero. A zero signal is defined as no signal in any channel of a given bank. The simultaneous shift register can shift a zero, but the storage shift register must have a signal in at least one channel. Since a zero signal can be a perfectly valid bit of information, its use can often save a complete channel as indicated in Table 2. Therefore, because of the simplicity and economic advantage of its circuitry, the simultaneous shift register should be used wherever possible.

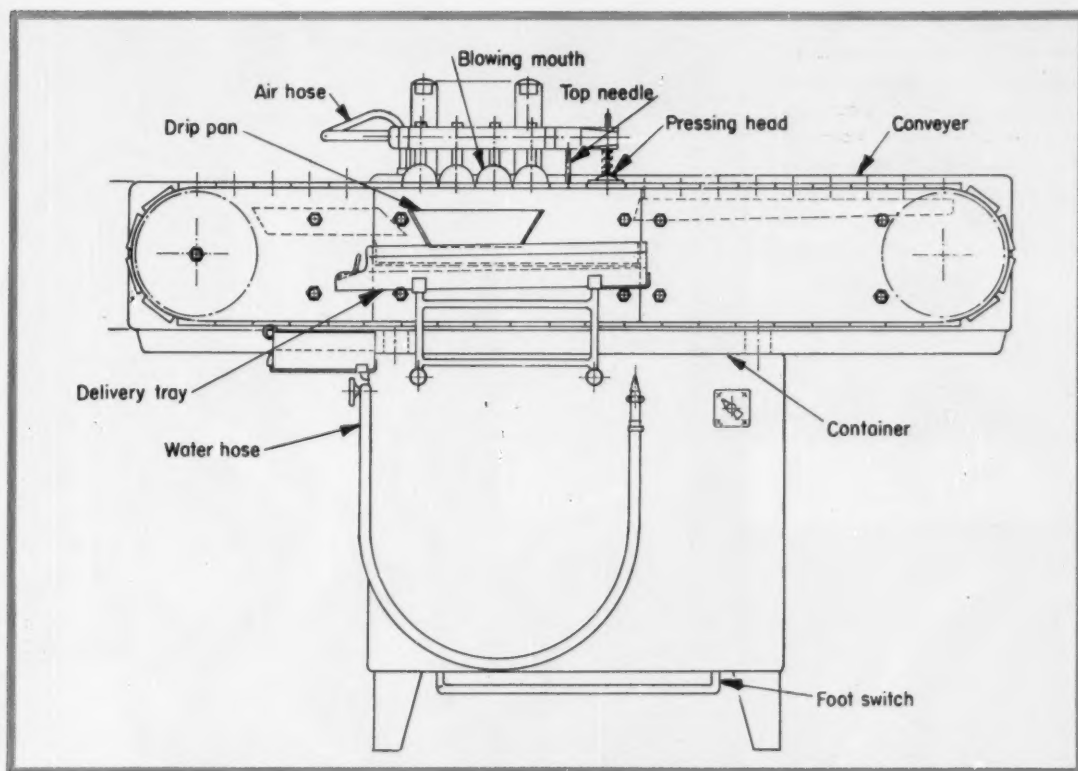
Either type of shift register can be made with *retentive* MEMORY elements to permit the system to be shut down and started up at any time without losing any of the information that was in the register at the time of shutdown. Also, because standard logic elements perform the functions, the control system can be easily modified to receive additional instructions or impose special restrictions. If future expansions will be required in a system, additional banks or channels can be added easily when they are needed.

Trouble-shooting on a shift-register control circuit is extremely simple. Monitor lights can be attached to the logic elements to provide a visual means of determining what and where each bit of information is. Monitor-light information can also be made available to an operator in a remote location to give him an instantaneous picture of the process at all times.

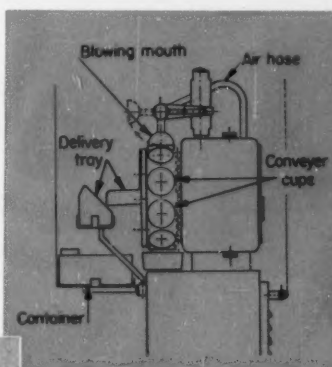
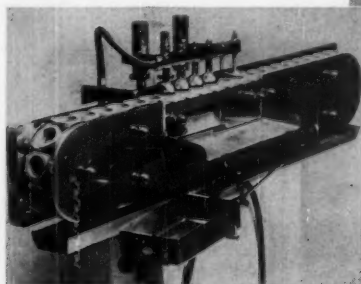
Table 2—Operations Possible With a Zero Signal

Number of Channels Required	Number of Operations Required (shift-register type)	
	Simultaneous	Storage
1	2	1
2	4	3
3	8	7
4	16	15
5	32	31
6	64	63

Mechanical Egg Blower Eliminates Hand Opening



EGG CUPS IN A CONVEYOR BELT carry eggs through a piercing device that pierces the shell top and bottom, and under mechanical blowing mouths. Contents are removed more completely and quickly than by hand breaking without danger of messy accidents.



Design of egg-emptying machine is by Bosch & Noltes, Amsterdam, Holland.

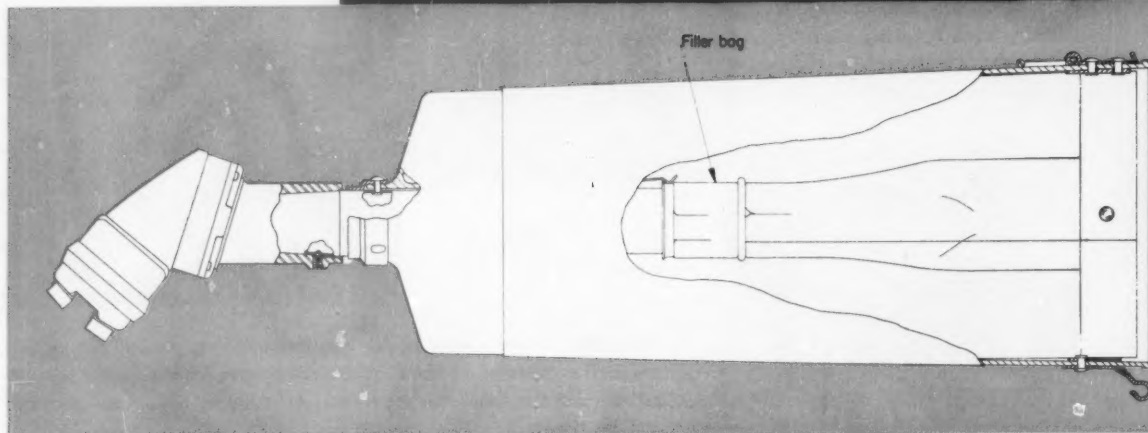
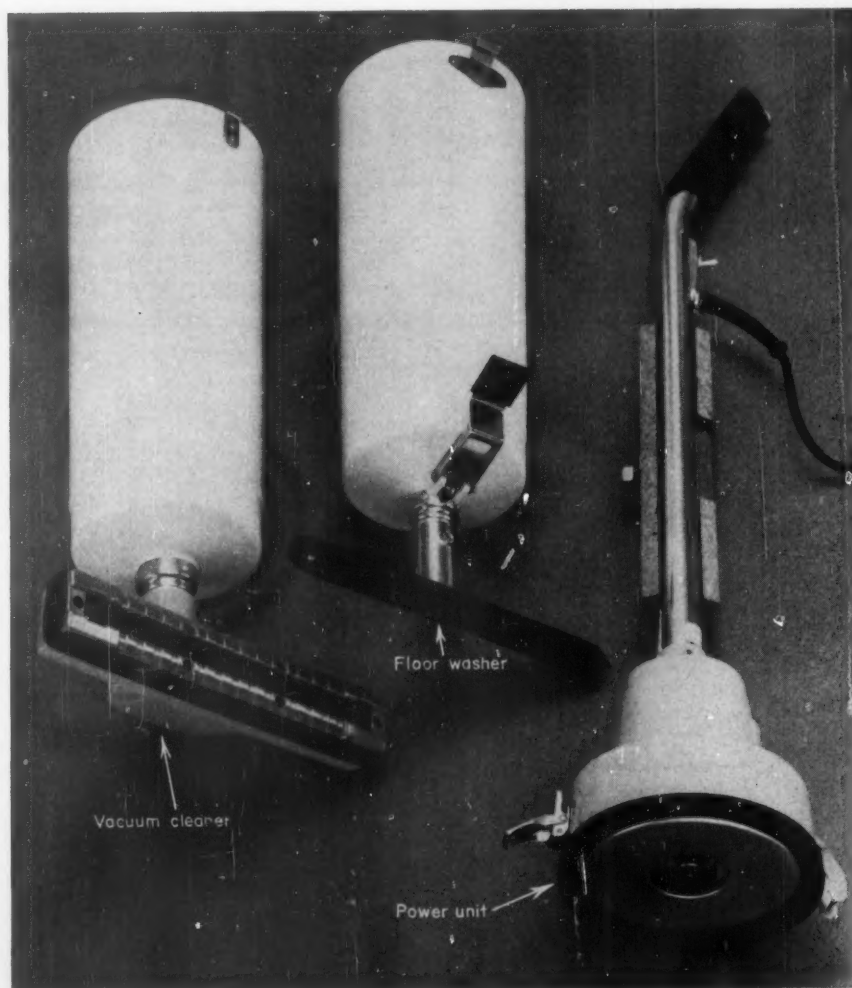


DRIP PAN isolates newly blown egg contents long enough for inspection. The operator removes questionable eggs with a water jet. A second operator loads the conveyer. As many as 5500 eggs per hour can be blown.

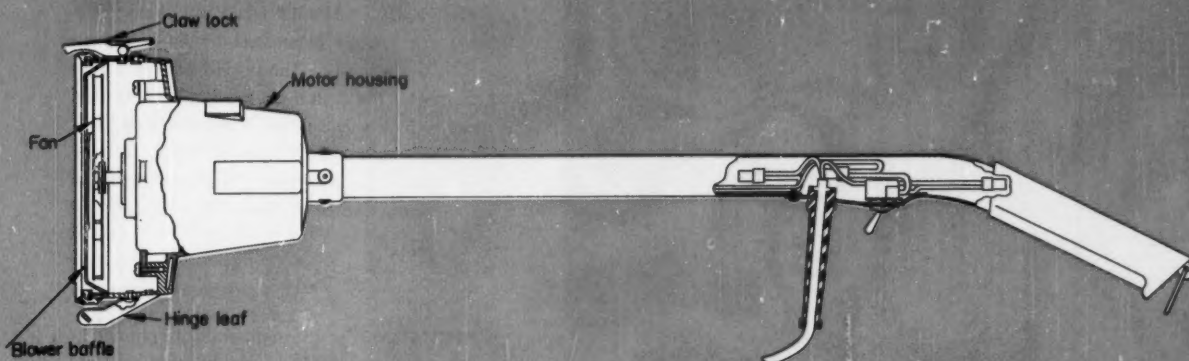
Lightweight Cleaner Converts to Washer

POWER UNIT IS ATTACHED to one of two working heads to produce either a vacuum cleaner or a floor washer. No carriage or wheels are needed to support the lightweight unit as it moves over floors or rug.

VACUUM CLEANER TANK FORMS part of the shaft from the handle to the nozzle. The disposable filter bag can hold 3 lb of dust or lint.



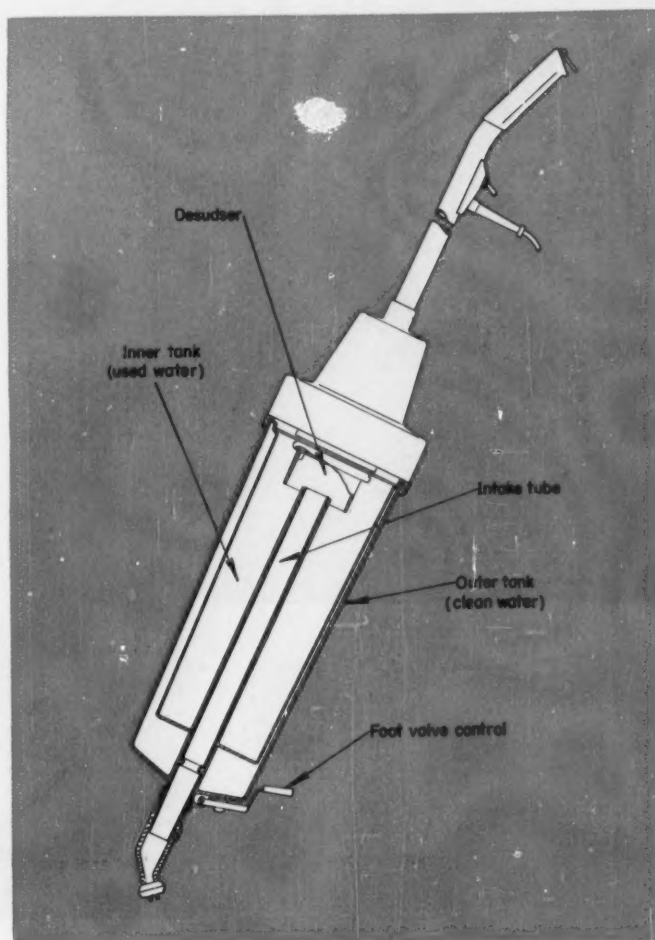
By Changing Tanks

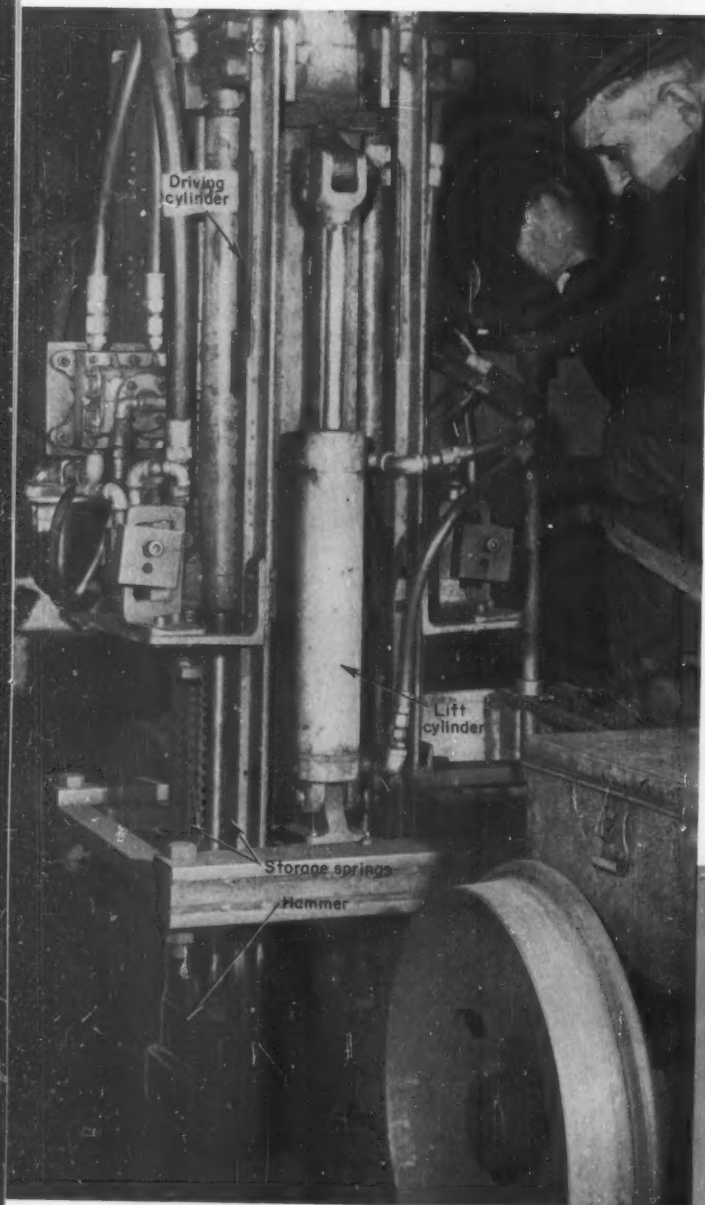


POWER SOURCE is a 14,000 rpm, 220-w motor on the handle. Fan is mounted on the motor shaft without gears or belts. Tanks are mounted with hinge leaves and claw lock.

OUTER TANK of washer holds enough water to clean a floor 12 x 20 ft. A foot valve controls release of clean water and detergent from the outer tank. After the floor is scrubbed, the vacuum draws the used suds up the intake tube into the inner tank. Desudser prevents suds and mist from flying into the power unit.

Combination cleaner called the Bissellelectric was developed by Bissell Inc., Grand Rapids, Mich.

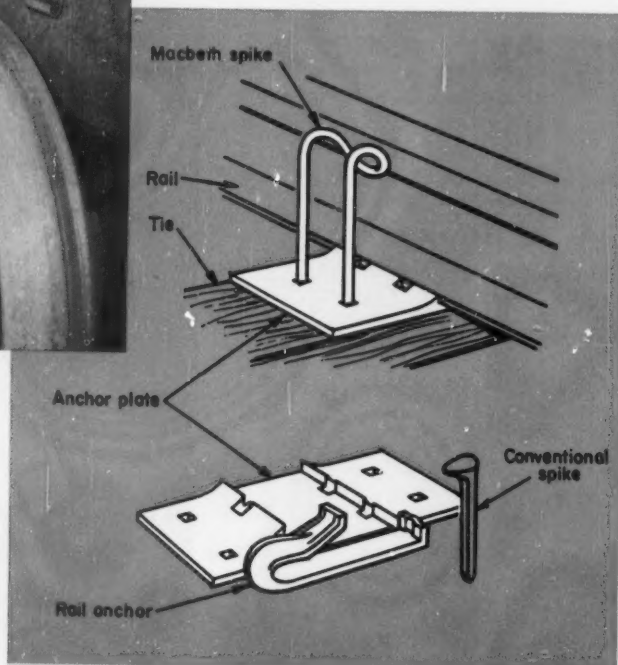




Impact Energy of

PNEUMATIC HAMMER DELIVERS nearly double the energy generated by its piston on the power stroke. The added energy is produced by the piston on the back stroke and stored in heavy springs. The resulting blow produces about 750 ft-lb of impact energy to force hard-to-drive Macbeth railroad spikes into seasoned ties in 6 strokes.

NEED AROSE for the high-energy hammer to drive Macbeth spikes, widely used in England and Europe, instead of conventional spikes in a customer's roadbed. Macbeth spikes eliminate the separate rail anchor, bypass broken spikes in old ties, and have superior holding power (it takes a 10,000-lb pull to extract one of them vs 4000 lb for a standard spike). Springy head resists vibration loosening. It's the same springiness in the head that causes the driving problem. Most of the energy in an ordinary spike driver is absorbed and the hammer bounces.

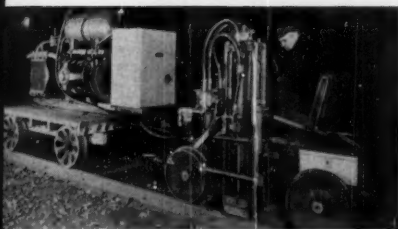


Rail-Spike Hammer Doubled by Storage Springs

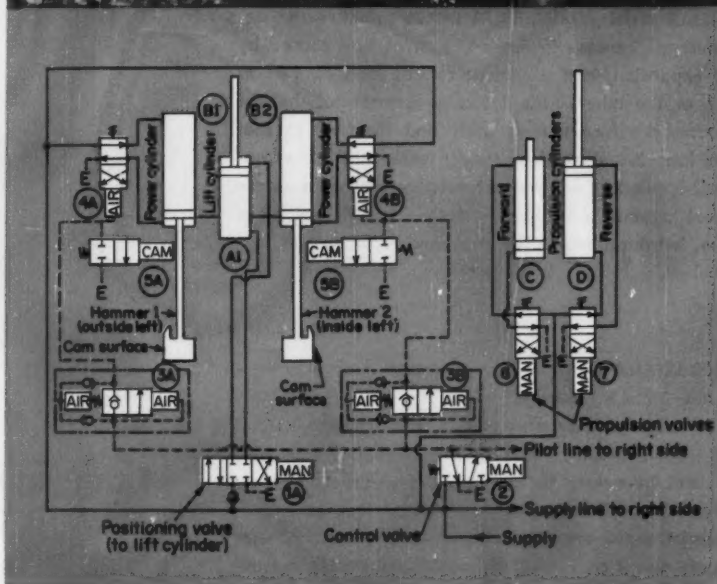
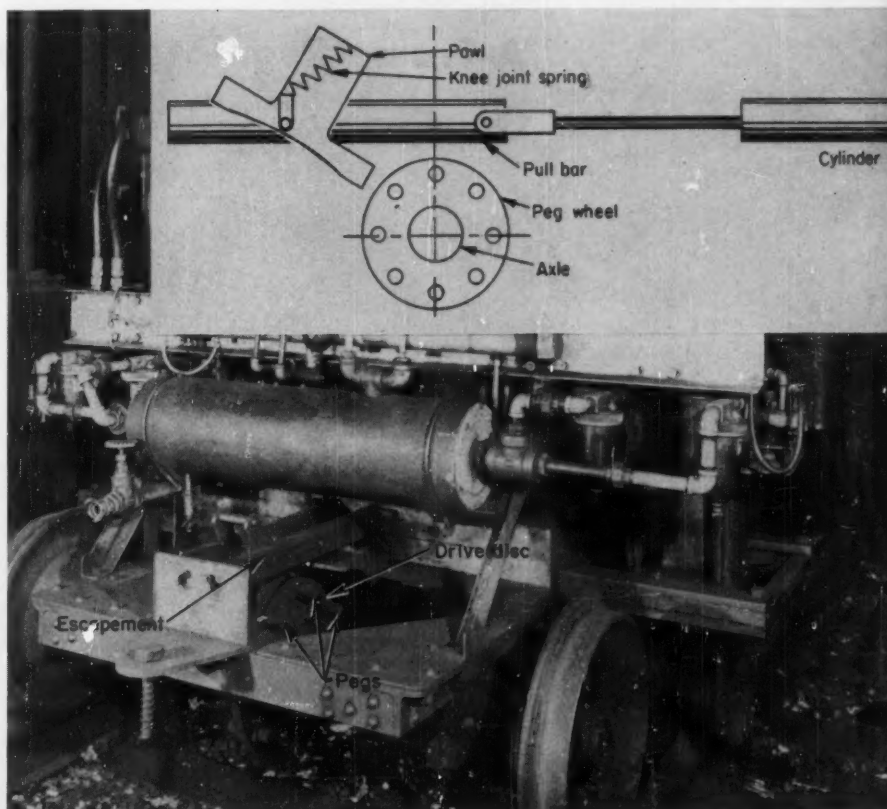
PROPULSION IS TRANSMITTED

to wheels through a drive disc that contains pegs in a bolt circle around its periphery. An escapement, driven by the propulsion cylinder, engages one of the pegs and indexes the disc thus propelling the carriage to the next spike location. Production models may use pneumatic or hydraulic rotary motors, says developer.

PROTOTYPE USES metal springs, but developer, the H. T. Kennedy Co., Inc., N. Y., says its patents include the use of pneumatic storage springs. Kennedy expects to use these and many other varieties of springs in future applications of the principle. Pressure for the pneumatic system was supplied by an electrically driven compressor mounted on a tender. Pneumatic valves were supplied by Ross Operating Valve Co., Detroit.

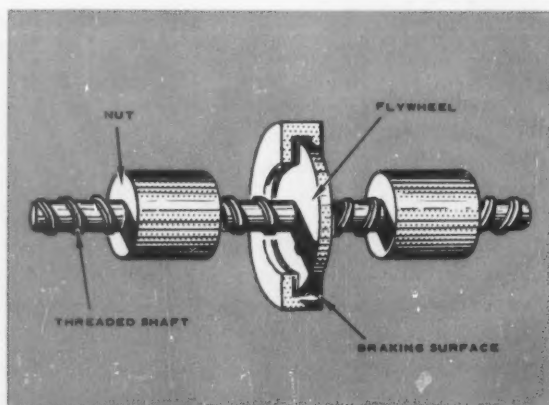


CAM SURFACES ON HAMMERS operate cam valves at the top of the back stroke to dump control air and reverse air valves. Hammers are accelerated downward by compressed springs and power-cylinder pistons.



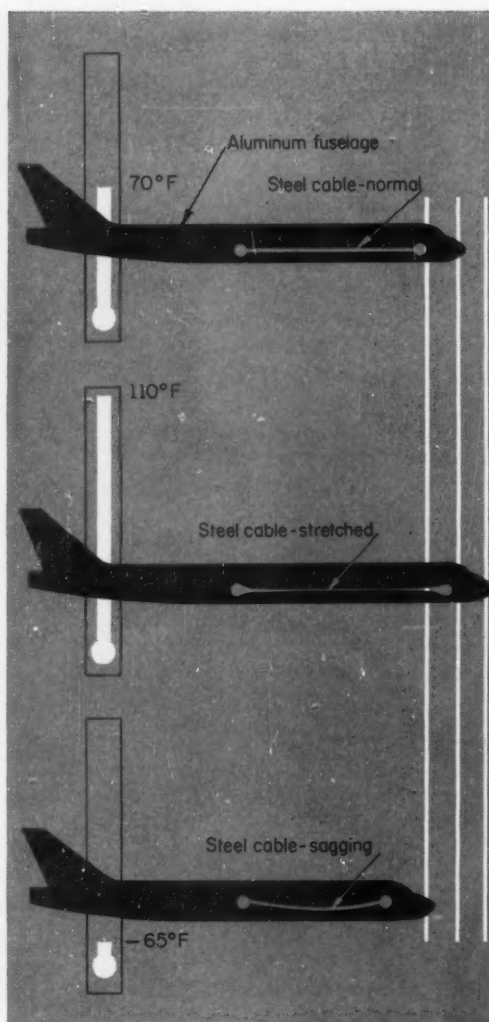
A-Frame Regulator Maintains Tension On Control Cables in Multijet Liner

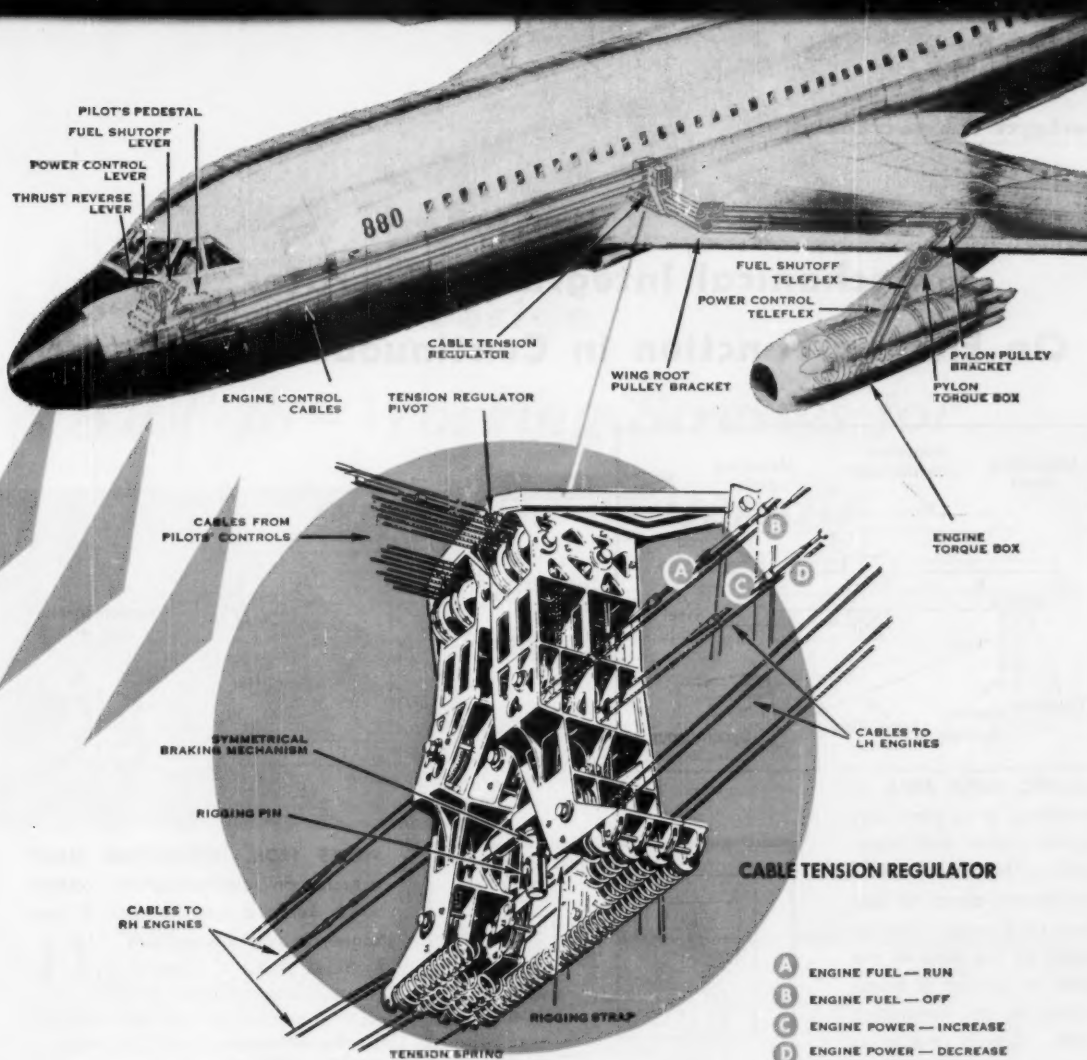
Turnbuckle brake filters
Command signals
From tension loads



TURNBUCKLE WITH SYMMETRICAL BRAKE differentiates between over-all increase in tension, such as that caused by thermal expansion, and a specific control load applied to one side or the other. The typically symmetrical thermal load causes the free-running shaft and flywheel to spin until the load is balanced by spring tension. But the control load, applied to one nut only of the turnbuckle, forces the wheel against a braking surface. The control load, therefore, is transmitted to the proper member.

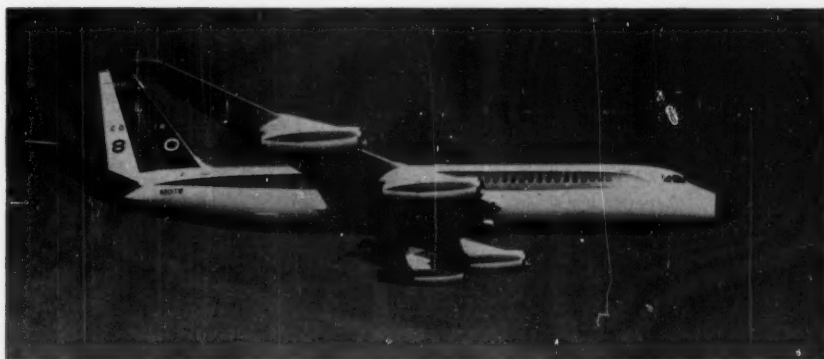
NEED FOR REGULATOR arises from dissimilar thermal properties of aluminum in fuselage and steel in cables, and from the wide range of temperatures in which jet aircraft must operate. For example, 100 ft of cable properly tensioned at 70 F will be nearly $\frac{3}{4}$ in. too short at 160 F, and yet the same cable will be more than 1 in. too long at -65 F. These temperatures are within the range of possibility with jet aircraft operation. Resulting variation in cable tension would be from 15 to 180 lb.





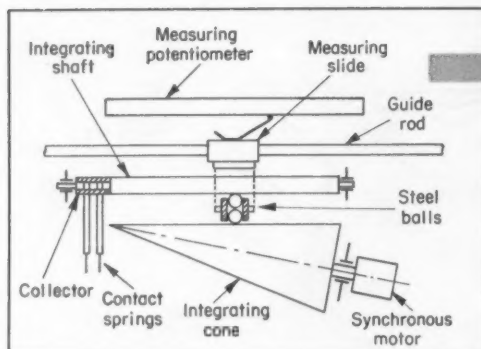
TENSION REGULATOR for control cables in a jet airliner is a hinged A-frame supporting all the cable pulleys. Springs at the bottom of the frame maintain tension at the proper level. Symmetrical braking mechanism

absorbs stresses due to thermal expansion, but transmits control signals. Regulator maintains adjustment on 16 cables—four for each engine of a four-engine airliner. Cables control engine fuel and power.

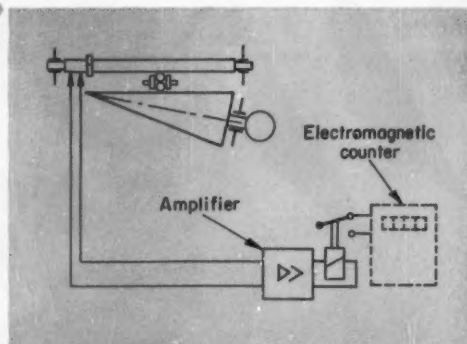


Cable-tension regulator is a development of Convair, San Diego, Calif., and is installed in the Convair 880 and also in the 600. Self-braking turnbuckle was developed by the Pacific Scientific Co. for Convair.

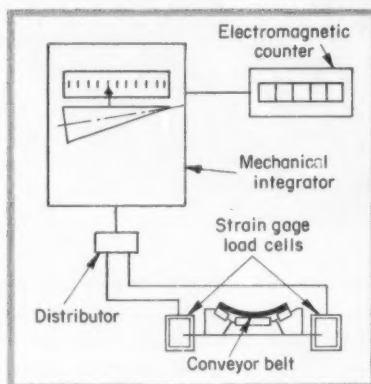
Mechanical Integrator Operates On Electric Function in Continuous Weigher



ELECTRIC INPUT FROM a weighing mechanism moves a steel ball transmission, by means of a servomotor, along the surface of a cone. Surface speed of the cone at the point of contact is transmitted to an integrating shaft. Cone's rotation is controlled by conveyor belt travel.

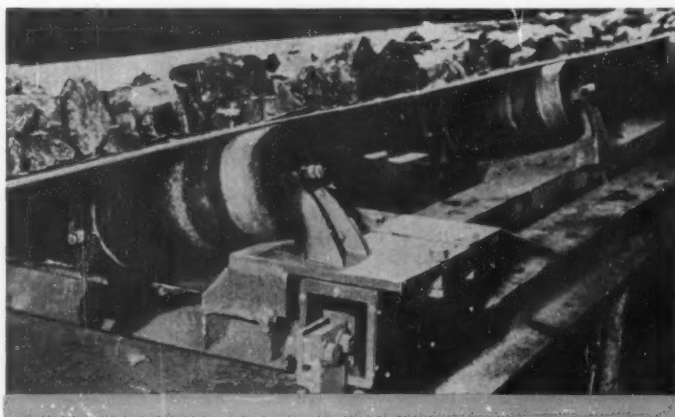


PULSES FROM INTEGRATING SHAFT actuate an electromagnetic counter which keeps a running total of load conveyed by conveyor belt.



Electromechanical weighing system was developed by Elektro Spezial GmbH, Hamburg, Germany.

STRAIN GAGES DEFLECT under conveyor load and change readings of a wheatstone bridge circuit in which they are incorporated. Resulting output is fed to the integrator.



Thermal Stresses in Design

PART 18—Working Stresses for Ductile Materials

- Design Approach
- Strain Range

S. S. MANSON

Chief, Materials and Structures Research Div.
Lewis Research Center, NASA
Cleveland, Ohio

DUCTILE materials rarely fail upon the application of a single cycle of thermal stress.³ Cracks develop and propagate by gradual deterioration due to alternate cycling of tensile and compressive plastic flow. Finally, the machine part or structure becomes useless for the intended purpose. Thus, an important design consideration is choosing design stresses with corresponding plastic strains that do not induce failure during the desired number of cycles.

In the previous discussion of thermal-stress fatigue of ductile materials, main emphasis was placed on completely constrained specimens. All thermal expansion was converted to mechanical strain, partly elastic and partly plastic. Further, the principal factor governing cyclic life was determined to be the plastic strain per cycle, Equation 11.³

Thus, when the plastic strain per cycle was known, the life could readily be determined. Applicability of the equation might be invalidated in some cases when complex metallurgical phenomena occur at high temperatures.³

Determining the plastic strain per cycle is more complicated in a machine part having a complex temperature distribution than in a laboratory test specimen which is under complete thermal constraint. Simplifying assumptions such as the principle of elastic-strain invariance are useful in preliminary calculations, and in some cases, even in final design.¹⁵ However, there are cases in which considerable error can result from its application. Hence, final design of important machine com-

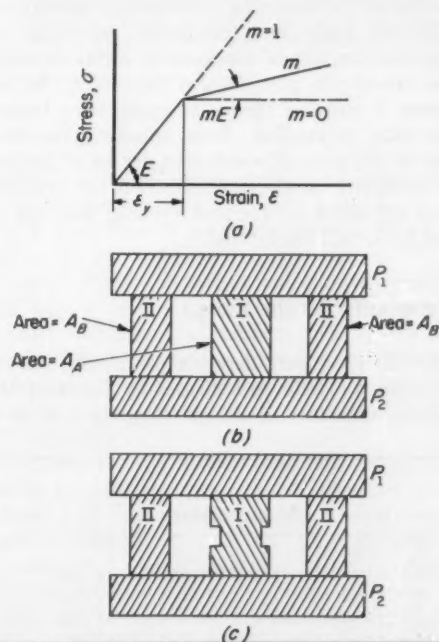


Fig. 109—Component analogue for thermal-stress problems. Shown is, *a*, typical stress-strain curve; *b*, uniform concentric cylinders, bars I and II, constrained by plates P_1 and P_2 ; and *c*, arrangement *b* with bar I of reduced center cross-section.

*References are tabulated at end of article

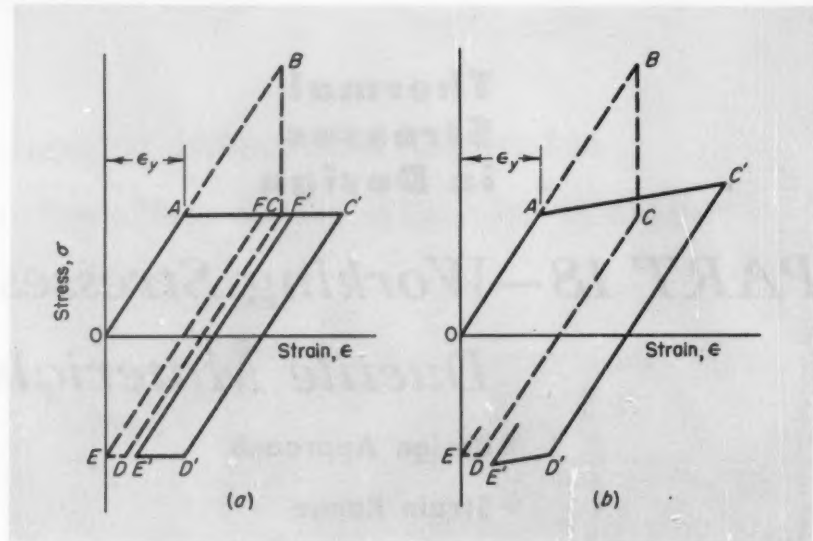


Fig. 110—Stresses and strains developed in bar I of Fig. 109 when temperature of either bar II is cycled.

ponents should be based on the most sophisticated methods of stress analysis available.

Discussion of design for ductile materials naturally divides itself into two cases—one in which a steady average stress is present, and one in which only cyclic plastic strain occurs under essentially zero average stress. Determining whether the mechanical and thermal loads are completely repetitive, or whether the intensity of the loading varies throughout the life of the part, is also important. In the latter case, a suitable theory of cumulative fatigue damage must be applied. Some consideration must be given to the state of stress—the degree of biaxiality or triaxiality of stresses. Behavior of machine elements subjected to thermal cycling, but not to external load, will be covered.

► Determining Strain Range

Cyclic life of a part depends principally on the plastic strain per cycle, as indicated by Equation 11.⁸ Hence, the objective of design computations is to

determine the location and magnitude of the largest plastic strain per cycle. For analytical purposes, it is equally valuable to consider the total strain range. Since total strains are the quantities that enter into the compatibility equations, they can sometimes be dealt with more conveniently than plastic strains. Three methods for determining the strain range and its component parts will be discussed.

Since thermal-stress problems arise in machine parts which have a wide degree of complexity in both geometric shape and temperature distribution, the most general problem cannot be described in specific terms. Hence, the simplest case incorporating the essential features that complicate the problem is considered.

Fig. 109 shows the example to be used. Bars I and II are concentric cylinders of areas A_A and A_B , respectively. The ends of the bars are attached to rigid plates, P_1 and P_2 . Bar II is assumed to be heated and cooled in succession. When heated it tends to expand, but the expansion is partially restrained by bar I through attachments P_1 and P_2 . The plates are assumed rigid enough so that the net lengths of bars I and II are always equal.

Stress-strain curves for the materials of both bars are assumed the same, despite temperature variations. Although the procedures to be discussed are valid for any shape of stress-strain curve, some of the specific computations will be made for the type of stress-strain curve shown in Fig. 109a. The elastic region is a straight line of slope E up to yield strain ϵ_y . This region is followed by a linear strain-hardening range of slope mE . For ideal plasticity, that is, no strain hardening, $m = 0$. For most materials, m can be expected to lie between zero and 0.1.

When bar II is heated to a sufficiently high temperature, tensile plastic flow occurs first in the bar

Nomenclature

A	= Area, sq in.
G	= Material constant (determined by test)
k	= Constant
l	= Length, in.
M	= Material constant (determined by test)
m	= Measure of strain hardening
T	= Temperature, F
α	= Coefficient of expansion, in./in./deg F
ϵ	= Strain, in. per in.
σ	= Stress, psi

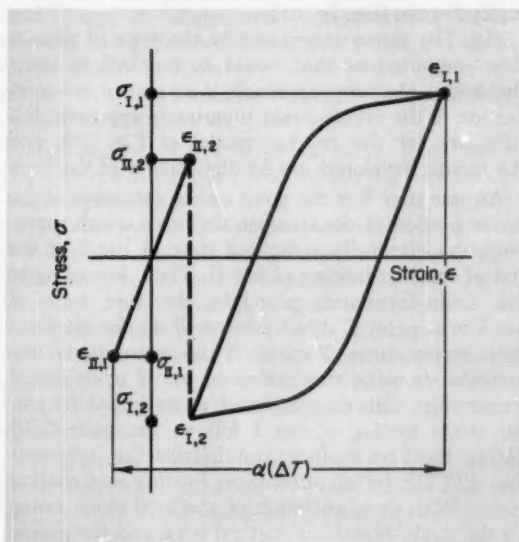


Fig. 111—Asymptotic stresses and strains for the system of Fig. 109*b*.

having the smaller area which, for illustrative purposes, will always be taken as bar I. For ideal plasticity, plastic flow can only occur in bar I, but for strain-hardening materials, plastic flow can occur in both bars.

Upon return of bar II to the initial temperature, bar I may be caused to flow in compression, the amount depending on the temperature cycling range and the area ratio A_A/A_B . The two bars, each having a different temperature and each influencing the strain in the other, introduce the significant factors present in a machine part. Temperature and load-carrying capacities are distributed throughout the structure. General features to be deduced from this problem provide insight into several of the variables in more practical problems.

In Fig. 109c, a reduced section occurs in bar I. For configurations such as this, simplifying approaches for strain determination involve the greatest errors.³ Hence, such cases will be treated separately in this article.

Elastic-Strain Invariance Method: A simple procedure for determining strain range is based on the approximate equality in total mechanical-strain distribution in the elastic and plastic range. Temperature distribution dictates a given strain distribution, and this distribution will be achieved whether the material is elastic, or whether it must flow plastically in some regions.

This assumption is based on the observation that the elastically computed strain distribution does not depend on the elastic modulus if the modulus is constant throughout the body.¹⁶ For many applications, good results can be achieved simply by making computations of the elastic strains during the first thermal loading, and assuming that these strains are the total strain ranges in subsequent

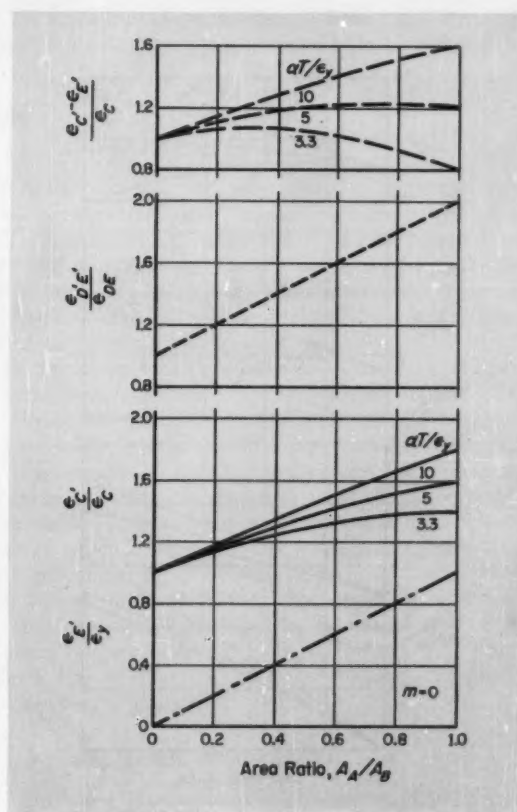


Fig. 112—Strains predicted by strain invariance method compared with those computed from ideal plasticity for the mechanism of Fig. 109. Subscripts refer to notation in Fig. 110a.

loading. Although quite useful, this approach cannot be rigorously correct.

If a discontinuity in temperature, area, or hardness exists in a constrained bar, the error can be extreme.³ While an elastic calculation would indicate only a modest increase in localized strain for a small localized area reduction, considerations of plastic flow indicate an almost complete localization of strain in the reduced area. Resulting strain in some cases can be many times that computed from elasticity.

In general, the elastic-strain distribution constitutes a compatible strain system resulting in elastic stresses that satisfy the equilibrium equations. But, plastic stresses determined from these strains in conjunction with the stress-strain curve do not generally satisfy the equilibrium equations.

The degree to which equilibrium equations are violated will depend on the volume subjected to plastic flow. If this volume is low, the elastic strains and attendant plastic stresses will be nearly correct. Consequently, the equilibrium equations will be violated only in a small region. If the volume under plastic flow is a large fraction of the total volume, the true stress distribution may be in general violation of the equilibrium equations. Hence,

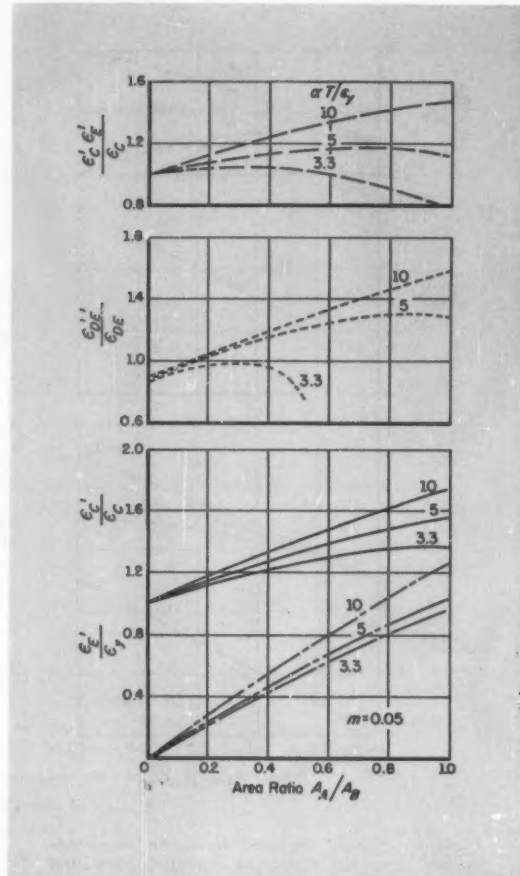


Fig. 113—Strains predicted by strain-invariance method compared with those computed from ideal plasticity after initial strain hardening for the mechanism of Fig. 109. Subscripts refer to notation in Fig. 110b.

the solution obtained by the assumption of strain invariance may be in considerable error.

Initial-Plasticity Method: Because of the potential limitations of the elastic-strain invariance approach, an alternative procedure must sometimes be used. This procedure is based on plasticity computations.^{11, 12, 13} To make such computations, the initial plasticity during the first thermal loading cannot be considered by itself. Strains that develop during the thermal unloading portion of the cycle must be considered.

Progressive computations must be made for as many cycles of heating and cooling as are necessary to establish essentially unchanged conditions in subsequent cycling. To make such computations, progressive change of yield point due to cycling must be known. Lack of generalized information on suitable assumptions make such computations difficult. But, at least the strains developed during the first cycle of loading and unloading can be computed with a fair degree of accuracy. The assumption that the strain range developed in

the first complete cycle persists throughout remaining cycles can then be made.

Fig. 110 shows schematically the type of plastic-flow computations that would be required in using the initial plasticity approach. Also shown for comparison is the elastic-strain invariance approach. Results are for the two-bar model of Fig. 109, and the strains developed are for the smaller of the bars.

Assume that *B* is the point on the extension of the linear portion of the stress-strain curve which represents the elastically computed state of bar I at the end of the first heating of bar II. Then, according to the strain-invariance principle, the true state of bar I is at point *C* directly below *B* on the idealized stress-strain curve. Further, if the conventional assumption is made that return of bar II to its initial temperature also returns bar I to its initial length, the strain cycling of bar I follows the path *CDE* during the first cooling, and follows the hysteresis loop *EFCD* for all subsequent heating and cooling cycles. With these assumptions, the total strain range for the strain-invariance method is ϵ_B , and the plastic strain per cycle becomes $\epsilon_B - 2\epsilon_y$.

However, assume that a plastic-flow computation shows the true state of bar I during the first heating of bar II to be at *C'* rather than at *C*. Also, assume that the subsequent cooling of bar II affects bar I and causes a return to point *E'*, not the zero-strain condition at *E*. Then, the true hysteresis loop followed in cyclic heating and cooling becomes *E'F'C'D'E'*.

True conditions to which the material is subjected depend on two factors—true strain ϵ'_C at the end of the first heating cycle, and remaining strain ϵ'_B at the end of the first cooling cycle. The total strain range then becomes $\epsilon'_C - \epsilon'_B$, and the plastic strain per cycle becomes

$$\epsilon'_C - \epsilon'_B = \epsilon'_C - 2\epsilon_y - \epsilon'_B \quad (138)$$

When strain hardening is to be considered, the new yield point σ'_D in Fig. 110b must be determined during the initial unloading. Unfortunately, different materials behave differently with regard to Bauschinger effect. The simplest assumption is that yield stress σ'_D in compression is equal to the initial yield stress σ_A . This assumption has been made in some of the numerical examples to be discussed later.

Basically, the stress range continuously changes in subsequent cycling. Assuming a particular yield stress provides a means for determining an initial total-strain range which is believed to persist throughout subsequent cycling. Expressions previously given for the total and plastic-strain ranges are then valid for the strain-hardening case shown in Fig. 110b.

Asymptotic Method: Even in the simplest case of strain cycling between fixed limits, the stress range continuously changes as a result of strain hardening or softening. After a few cycles, a specimen cycled under constant strain range usually settles down to a relatively constant stress range related almost solely to the strain range.

For a structural element, the strain range is not

necessarily constant, but depends on the stress range itself. Thus, a "shakedown" period would be expected. During this period the stress range and strain range would progressively change and approach asymptotic values until relatively little further change would take place in these quantities.

Suppose that, for a given material, there exists a unique relationship between stress range and strain range expressible either in analytical form, or as a curve analogous to the stress-strain curve. How can a method be devised to use this stress range and strain range relation to determine the asymptotic values of strain range developed in each point of the structure under evaluation? To indicate the basis for this type of computation, an elementary problem for which the procedure is evident will be considered. Then, this procedure will be generalized for more complex cases.

Consider the two-bar problem of Fig. 109 when the temperature of bar II is cycled while that of bar I is maintained constant. Assume that the cross-sectional area of bar II is large relative to bar I, so that bar II always remains within the elastic range. In the initial cycle of temperature, the stress developed in bar II depends on the uniaxial stress-strain curve. But, as further cycling progresses, the stress range in bar I changes. This stress range in bar I is the only force causing stress in bar II. Thus, as the stress range in bar I changes, the stress range in bar II also changes. Since bar II is elastic, the strain range is proportional to the stress range. Hence, as cycling proceeds, both stress range and strain range continuously change until, ultimately, asymptotic stress and strain ranges are achieved. Fig. 111 shows the stress-strain relations that are assumed to exist in the bars when the asymptotic condition is reached.

Equilibrium equations for the unknowns at the extremes of the cycle are

$$A\sigma_{I,1} + B\sigma_{II,1} = 0 \quad (139)$$

and

$$A\sigma_{I,2} + B\sigma_{II,2} = 0 \quad (140)$$

Compatibility equations are

$$\epsilon_{I,1} + \alpha T = \epsilon_{II,1} \quad (141)$$

and

$$\epsilon_{I,2} = \epsilon_{II,2} \quad (142)$$

Also,

$$\epsilon_{II,1} - \epsilon_{II,2} = \frac{\sigma_{II,2} - \sigma_{II,1}}{E} + \frac{M}{G} \left(\frac{\sigma_{II,2} - \sigma_{II,1}}{G} \right)^{a/k} \quad (143)$$

and

$$\epsilon_{I,1} - \epsilon_{I,2} = \frac{\sigma_{I,2} - \sigma_{I,1}}{E} \approx \frac{\sigma_{I,2} - \sigma_{I,1}}{E} + \frac{M}{G} \left(\frac{\sigma_{I,2} - \sigma_{I,1}}{G} \right)^{a/k} \quad (144)$$

Equations 143 and 144 are based on the relation between stress range and strain range and will be derived later. Equation 144 is only an approximation, since bar II is presumed elastic. But, the non-linear term in this expression is very small for stress

ranges within the elastic limit.

If Equation 140 is subtracted from Equation 139, and if Equation 142 is subtracted from Equation 141,

$$B(\sigma_{II,1} - \sigma_{II,2}) + A(\sigma_{I,1} - \sigma_{I,2}) = 0 \quad (145)$$

and

$$(\epsilon_{I,1} - \epsilon_{I,2}) + \alpha T = \epsilon_{II,1} - \epsilon_{II,2} \quad (146)$$

Equations 143, 144, 145, and 146 constitute the set of equations that would have been obtained if this simplified problem had been set up according to the conventional equilibrium and compatibility equations for this problem. But, stresses are replaced by stress ranges, strains are replaced by strain ranges, and the stress-strain relation normally embodied in the tensile stress-strain curve is replaced by the relation between stress range and strain range.

Procedure indicated here for the simple problem can readily be extended to the general case by using Equations 15, 16, and 20.⁶ From these, the procedure can be concluded as generally valid. Thus, any determination of asymptotic stress range and strain range which develops after a large number of cycles becomes exactly the same as any conventional plasticity problem, except that the conventional stress-strain relation is replaced by a stress range and strain range relation. All the techniques that have been discussed for the solution of plastic-flow problems become applicable.

► Comparison of Methods

Since the elastic-strain invariance method is the easiest to apply, results obtained by its application

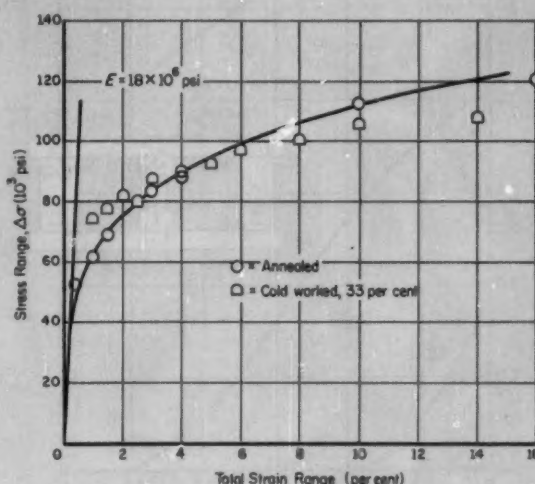


Fig. 114—Relation between stress range and strain range for copper.

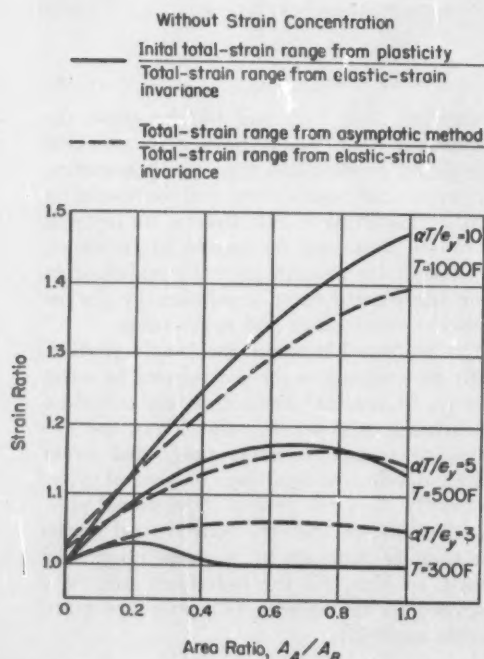


Fig. 115—Initial total-strain range from plasticity compared with total strain range from asymptotic method.

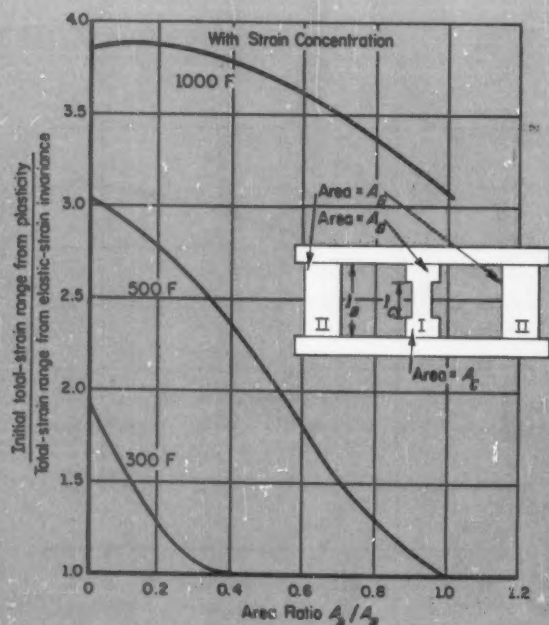


Fig. 116—Nature of strain concentration can cause gross errors when elastic-strain invariance method is applied to configuration shown in Fig. 109c.

will be compared with those obtained by the other two methods. Comparisons will be made for the cases shown in Fig. 109.

Elastic-Strain Invariance and Initial Plasticity: Fig. 112 shows some comparisons obtained by using the first two of the methods discussed for determining the strains. This figure is for ideal plasticity, and for the system containing no reduced cross-sections, as shown in Fig. 109b.

SOLID LINES show ratio ϵ_C'/ϵ_C . This ratio depends on area ratio A_A/A_B as well as on the magnitude of the cyclic temperature fluctuations in bar II.

Three sets of curves are shown for $\alpha T/\epsilon_y = 10$, 5, and 3.3, where T is the temperature range in bar II, and ϵ_y is the yield point for the assumed idealized material. The plastically determined strain is always greater than the elastically determined value, the error becoming greater as the temperature range of bar II is increased.

DOT-DASH CURVE of Fig. 112 shows remaining strain ϵ_B' in bar I after the initial temperature has been restored to bar II. When measured as the ratio to yield strain ϵ_y , this remaining strain is independent of temperature T , and depends only on the area ratio. The higher the area ratio between bar I and bar II, the greater is remaining strain ϵ_B' .

DOTTED LINE in Fig. 112 shows the ratio between the plastic strain per cycle as computed from a detailed plastic analysis, and the plastic strain determined from an elastic analysis and application of the strain-invariance principle. Ratio $\epsilon_{D'B'}/\epsilon_{DB}$ is independent of the temperature range, and dependent only on the area ratio. The higher area ratio A_A/A_B , the greater is the difference between the plastic strains determined by the two methods.

DASH-DASH LINES in Fig. 112 show the ratios of total strains computed by the two methods. For very low values of $\alpha T/\epsilon_y$, and high area ratios, the total strain computed by elastic-strain invariance method can actually be too high. But, for high temperature ranges, the elastic-strain invariance method will, in general, predict too low a value, implying a longer life than that predicted on the plastic strain distribution in the first cycle. On the other hand, the two methods of total strain prediction differ by less than 20 per cent over a rather wide range of geometry and temperature cycling. This indicates that elastic-strain invariance can be reasonably applied for preliminary design.

Fig. 113 shows strain comparisons similar to those of Fig. 112 except that the initial strain hardening of the material has been included. Results are shown for a value $m = 0.05$ for the strain-hardening portion of the curve. To make discrete computations, an assumption regarding yield point σ_D' upon reverse loading was necessary. For the computations shown, the yield point in reverse loading was assumed to be equal to the initial yield point, or $\sigma_D' = \sigma_A$.

As seen in Fig. 113, the strain upon initial yielding is greater when plasticity is considered than when it is neglected, $\epsilon_C'/\epsilon_C > 1.0$ for all values of

αT considered. A substantial strain, $\epsilon_{E'}$, remains after the temperature is removed.

Thus, plastic strain $\epsilon_{D'E'}$ may be more, or it may be less than value ϵ_{DE} computed from elastic-strain invariance. The error depends on the temperature range of the heated bar, the area ratio between the bars, and the shape of the strain-hardening portion of the curve.

When the temperature range is small, much of the thermal expansion is taken up by elastic strain resulting from increase of stress in the strain-hardening range. This causes the plastic strain to be considerably reduced. This is particularly evident in the curve for $\epsilon_{D'E'}/\epsilon_{DE}$ for $\alpha T/\epsilon_y = 3.3$ in Fig. 113. Ratio of plastic strains is less than unity for all area ratios.

As in the case of the material with no strain hardening, the total strains computed on the basis of strain invariance is within 20 per cent of the strains computed by initial plasticity over a wide range of geometry and temperature.

Elastic-Strain Invariance and Asymptotic Strain Hardening: Since the asymptotic strain-hardening method is concerned primarily with determining the strain range, comparison will be made of this quantity as determined by the two methods. To apply the strain-hardening method, the asymptotic strain-hardening characteristics of the material are needed. They can be obtained with relatively little experimental cycling, as will later be discussed.

For the illustrative example, the stress range-strain range characteristics of copper, Fig. 114, was used. Fig. 115 shows the results of computations in two sets of curves. For this problem, the actual temperature ranges are shown, since a specific material is involved.

SOLID LINES show the ratios of the initial total strain range determined from initial plasticity to total strain range determined from elastic strain invariance.

DOTTED CURVES indicate that the numerator of the ratio is the strain range determined by the asymptotic method while the denominator remains the same. Differences in results between the two methods are relatively small, and the curves indicate that for preliminary design, the simple elastic-strain invariance method may be satisfactory. Unfortunately this conclusion is not completely general.

Cases Involving Strain Concentration: Although the method of elastic strain invariance gives a good account of itself for the problems thus far discussed, there are cases in which gross error can result from its application. Fig. 116 shows some results of computations for the configuration shown in Fig. 109c. Here, bar I has a reduced section along only 10 per cent of its length. To be exact, the reduction in cross section is assumed to be only 10 per cent. On the basis of elastic analysis, relatively little strain concentration occurs in the reduced section. But, on the basis of a plastic analysis, most of the thermal

expansion along the entire length of bar II must be absorbed in the small length of the reduced section of bar I. Hence, a considerable strain concentration occurs.³ Fig. 116 shows that the error in determining the total-strain range can be a factor of nearly four, depending on the nature of the strain concentration.

Summary of Comparisons: On the basis of the foregoing simplified examples, the elastic-strain invariance approach can yield very reasonable estimates of total strains in cases not involving unusual geometric or thermal conditions. Because of the possibility of unusual conditions destroying the validity of elastic-strain distribution, the best design approach for determining the strain range may be that based on asymptotic strain hardening. Type of data required can be determined with relative ease in the laboratory and the computations involved are no more difficult than those used in ordinary plasticity analysis.

REFERENCES

This article is the eighteenth in a series by S. S. Manson on thermal stresses in design. Previous articles and issues of MACHINE DESIGN in which they appeared are:

1. "Appraisal of Brittle Materials" June 12, 1958
2. "Quantitative Techniques for Brittle Materials" June 26, 1958
3. "Basic Concepts of Fatigue in Ductile Materials" August 7, 1958
4. "Causes of Fatigue in Ductile Materials" August 21, 1958
5. "Interpretation of Fatigue Data for Ductile Materials" September 4, 1958
6. "Elastic Stress Analysis" January 22, 1959
7. "Exact and Approximate Solutions" February 5, 1959
8. "Elastic Stresses by Energy Methods" February 19, 1959
9. "Elastic Stress Solutions" March 5, 1959
10. "Elastic Stresses by Minimizing Residuals" March 19, 1959
11. "Stresses Under Plastic Flow and Creep" July 9, 1959
12. "Plastic Stresses and Strains by Successive Approximations" July 23, 1959
13. "Incremental Solutions for Plastic Stresses and Strains" August 6, 1959
14. "Strain Gage Measurements" October 29, 1959
15. "Strain Gage Applications" November 12, 1959
16. "Measurements by Photoelasticity" November 26, 1959
17. "Determining a Safe Working Stress" June 9, 1960

Tips and Techniques

Adding Degrees and Minutes

A desk calculator can easily be used for adding and subtracting numbers of different dimensions, such as angular degrees and minutes. The first three columns on the keyboard are used for degrees, the last three, for minutes. The sums are then properly combined. This method eliminates the separate operation of converting minutes to decimal values of degrees.

Other applications include hours and minutes, and integers and fractions (by first converting the latter mentally to a common denominator such as sixteenths or thirty-seconds).—RICHARD M. EVANS, *ITT Laboratories, Fort Wayne, Ind.*

How to find

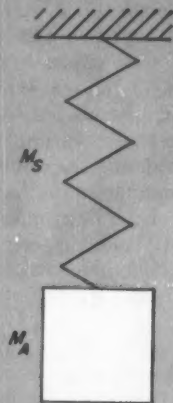


Fig. 1—Simple spring-mass system.

VIBRATION problems in simple spring-mass systems, Fig. 1, can often be solved more easily if the system is reduced to a weightless spring and a springless (rigid) equivalent mass. However, to accomplish this simplification, the fraction of spring mass to be added to the attached mass must be determined.

When a helical spring of small helix angle oscillates at a frequency far below any natural frequency, the longitudinal motion of a point on the spring can be assumed to be proportional to the point's distance from the fixed end. Therefore, the total inertia of the system is equal to the acceleration of the moving end multiplied by the sum of the attached mass and one half of the spring mass. Thus, to compute inertia forces in this system, a single equivalent mass can be found by adding one half of the spring mass to the attached mass.

However, when the spring oscillates at its lowest longitudinal natural frequency, the motion of each point on the spring is more complicated. Moreover, the equivalent mass will be different. In such cases, the lowest natural frequency of the spring-mass combination can be determined from (see Nomenclature)

$$\omega^2 = \frac{k}{M_E} \quad (1)$$

Equivalent Spring

FERDINAND FREUDENSTEIN

Chairman
Dept. of Mechanical Engineering
Columbia University
New York, N. Y.

where

$$M_E = M_A + \lambda M_s \quad (2)$$

These equations can be easily solved if the value of λ can be determined. Estimates for λ vary from $1/3$ to $1/2$.¹⁻⁷ In one instance, two types of equations are suggested with the choice depending on the weight ratio between attached element and spring. For close-wound springs in which the radius of

¹References are tabulated at end of article.

Nomenclature

- a = Velocity of propagation of a disturbance in spring, in. per sec
- D = Weight ratio
= W_s/W_A
- d = Wire diameter, in.
- f = Lowest natural frequency, cps
- k = Spring gradient, lb per in.
- l = Total developed length of spring, in.
- M = Mass, lb-sec² per in.
- n = Number of active spring turns
- r = Coil radius, in.
- W = Weight, lb
- λ = Spring-mass factor
- μ = Mass or weight-ratio factor
- ρ = Density, lb per cu in.
- ω = Lowest natural frequency, rad per sec

Subscripts

- A = Attached end mass
- E = Equivalent (system)
- S = Spring

Mass *for simplified analysis of vibrating spring systems.*

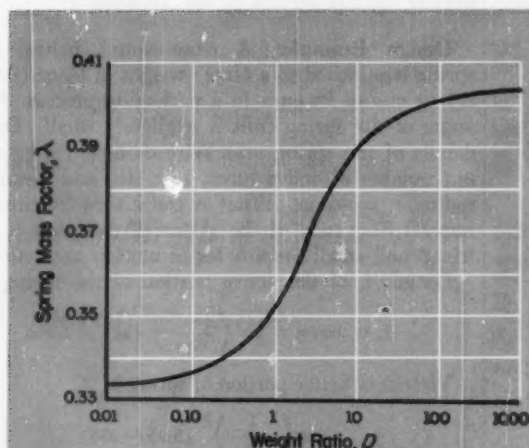


Fig. 2 — Relationship of spring-mass factor λ to weight ratio D .

gyration of the wire cross section is negligible in comparison to the mean coil radius, an expression for the exact value of λ can be readily developed. Let²

$$\omega = \frac{a\mu}{l} \quad (3)$$

where

$$\mu \tan \mu = D \quad (4)$$

and

$$\frac{a}{l} = \sqrt{\frac{k}{M_R}} \quad (5)$$

In these equations, ω is the lowest natural frequency of longitudinal vibration of the spring-mass system, Fig. 1, for zero damping.

By transformation, Equations 3 and 5 become

$$\omega = \sqrt{\frac{k}{M_A + \lambda M_R}} \quad (6)$$

where

$$\lambda = \frac{\tan \mu - \mu}{\mu^2 \tan \mu} \quad (7)$$

The exact value of λ for any weight ratio, D , has been evaluated from Equation 7 with a digital computer. Results are shown in Table 1 and Fig. 2. Two limiting cases are apparent:

1. Spring is massless. In this case, $D = 0$ and $\lambda = 1/3$. This value is most often quoted in literature.
2. Attached mass M_A absent. Here, $D = \infty$, $\mu = \pi/2$, and $\lambda = (2/\pi)^2 = 0.4053$. Even in this extreme case, the value of λ differs from $1/3$ by only 22 per cent.

Therefore, the value for λ falls in the range defined by a minimum of 0.3333 and a maximum of 0.4053.

It is evident that the value, $\lambda = 1/3$, is sufficiently accurate for most situations. However, certain con-

Table 1—Values of Spring-Mass Factor λ

D	λ	D	λ
0.00	0.3333	1.00	0.351
0.01	0.334	2.00	0.362
0.02	0.334	3.00	0.370
0.03	0.334	4.00	0.375
0.04	0.334	5.00	0.379
0.05	0.334	10.00	0.390
0.06	0.335	20.00	0.397
0.10	0.336	50.00	0.402
0.20	0.338	100.00	0.403
0.30	0.340	200.00	0.404
0.40	0.341	1000.00	0.405
0.50	0.343	∞	0.4053
0.75	0.347		

siderations should be kept in mind in applying the method presented here. Only the active portion of the spring should be "weighed." About $\frac{1}{2}$ coil at the fixed end is usually excluded. Also, the equations apply only to close-wound helical springs.

In the final analysis, whether or not use of a more accurate value than $\lambda = \frac{1}{3}$ is justified will depend on the nature of the application.

Design Example: A close-wound helical steel spring is attached to a (free) weight of $\frac{1}{2}$ oz (0.0313 lb) at one of its ends in a packaging process. Helix angle of the spring coils is negligibly small. Design details of the spring are: Wire diameter, $d = \frac{1}{16}$ in.; number of active turns, $n = 10$; and mean coil radius, $r = \frac{1}{4}$ in. What is the lowest longitudinal natural frequency of the system if damping is neglected and small amplitudes of motion are assumed?

Length l_a of the active portion of the spring is

$$l_a = 2\pi r n = 2\pi \left(\frac{1}{4} \right) (10) = 5\pi \text{ in.}$$

Weight of active portion of spring is

$$W_s = \frac{\pi d^2 l_a \rho}{4} = \frac{\pi \left(\frac{1}{16} \right)^2 (5\pi) (0.283)}{4} = 0.0136 \text{ lb}$$

where $\rho = 0.283$ lb per cu in. for steel.

Weight ratio is

$$D = \frac{W_s}{W_A} = \frac{0.0136}{0.0313} = 0.435$$

From Table 1, for $D = 0.435$, $\lambda = 0.342$. For helical circular-wire steel springs, Equations 5 and 6 can be combined to give

$$f = \frac{1146 d}{(r n) (r) \sqrt{\lambda + \frac{1}{D}}}$$

where $f = \omega/2\pi$ is the lowest longitudinal natural frequency. Solving this equation gives $f = 70.7$ cps.

ACKNOWLEDGEMENT

The author is grateful to the Electronics Research Laboratories of Columbia University for the use of computational facilities, and to Mr. Sy Newman of these laboratories for his programming and execution of the computations.

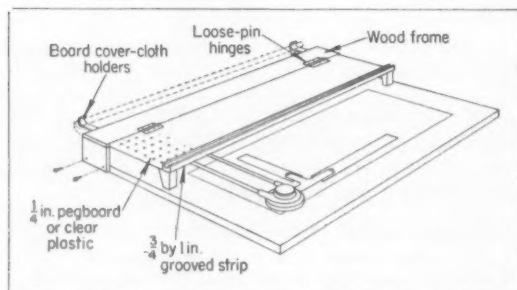
REFERENCES

1. J. E. Younger—*Advanced Dynamics*, The Ronald Press Co., New York, N. Y., 1958, pp. 132-134.
2. S. Gross and E. Lehr—*Die Federn*, VDI-Verlag, Berlin, Germany, 1938, p. 107.
3. L. S. Jacobsen and R. S. Ayre—*Engineering Vibrations*, McGraw-Hill Book Co. Inc., New York, N. Y., 1958, p. 70.
4. A. M. Wahl—*Mechanical Springs*, Penton Publishing Co., Cleveland, Ohio, 1949, p. 233.
5. J. P. Den Hartog—*Mechanical Vibrations*, McGraw-Hill Book Co. Inc., New York, N. Y., 1940, p. 430.
6. J. N. Macduff and J. R. Curreri—*Vibration Control*, McGraw-Hill Book Co. Inc., New York, N. Y., 1958, p. 103.
7. S. Timoshenko and D. H. Young—*Vibration Problems in Engineering*, D. Van Nostrand Co. Inc., New York, N. Y., 1955, pp. 312-316.

Tips and Techniques

Reference and Instrument Shelf

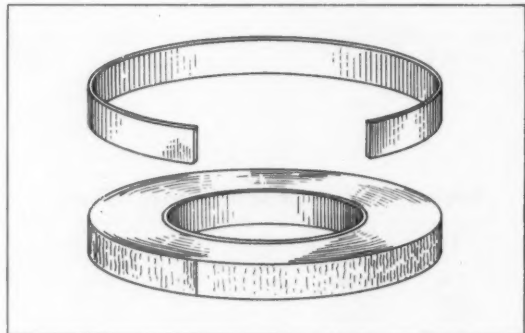
When a drafting machine is mounted on a board, reference space is at a minimum because of the clearance needed for the machine's arms. The illustrated shelf regains most of this space, useful for templates



and instruments as well as reference material. The forward part of the shelf is easily removed when the full board surface is required for large drawings.—ANTHONY B. CISTOLA, International Business Machines Corp., Owego, N. Y.

Tape Dispenser

A rolled-metal strip makes a simple, self-adjusting tape dispenser, complete with tearing edge.—ERMAN L. MAYS, Palo Alto, Calif.



Do you have a helpful tip or technique for our other readers? You'll receive ten dollars or more for each published contribution. Send a short description plus drawings, tables, or photos to: Tips and Techniques Editor, MACHINE DESIGN, Penton Bldg., Cleveland 13, O.

Designing External-Shoe BRAKES

... a direct graphical method for

- Accurately estimating brake-drum dimensions
- Determining brake-drum operating limits

H. A. BORCHARDT

Lecturer in Machine Design
University of New South Wales
Sydney, Australia

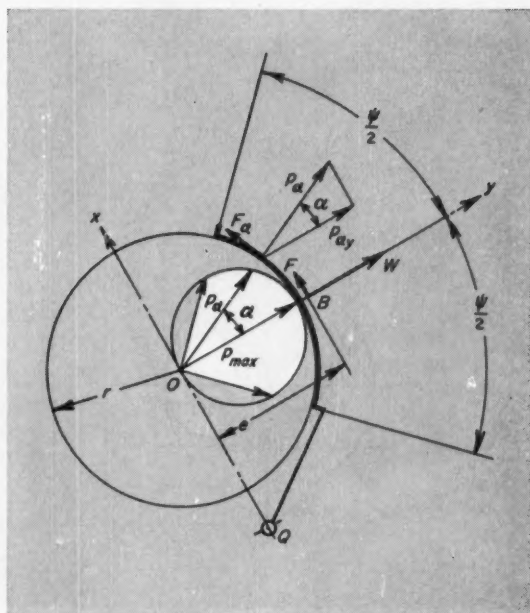


Fig. 1—Rigid-shoe brake with radial pressure distribution represented by a pressure circle.

DESIGN of external-shoe brakes usually involves a tedious and time-consuming analysis of variables. Many trial-and-error solutions may be necessary before a reasonable and satisfactory design is obtained.

Two problems frequently confronted in the design of external-shoe brakes are:

1. Estimating the drum dimensions of a shoe brake for a particular application.
2. Ascertaining the limits of duties which a given drum can perform.

This article presents a simplified method for solving these problems by nomographs. Although the nomographs cover a broad range of operation for the particular variables, certain restrictions on application should be noted. Optimum drum size can be obtained at standard conditions for:

1. Fixed brakes which have shoes rigidly attached to posts.
2. Pivoted brakes which have the pivot bolts tightened to make the pivot inoperative.
3. Pivoted brakes in which the resultant of all pressure and friction forces of the shoe (fixed to the post) passes through the pivot.

Additionally, certain post proportions have to be

adhered to. If standard conditions do not exist, a close estimate of the required drum size is possible.

Design Factors: Factors which limit the design of shoe brakes are heat dissipation, maximum pressure which the lining can sustain, and circumferential speed of the drum. Life of the lining is restricted by wear, which is greatest at points of maximum radial pressure. Thus, the brake should be designed

Nomenclature

a	= Distance between resultant pressure force and post pivot, in.
b	= Lining width, in.
c	= Distance between spring force and post pivot, in.
d	= Drum diameter, in.
e	= Distance between resultant friction force and drum center, in.
F	= Resultant friction force, lb
f	= Friction force on lining element, lb
h	= Heat coefficient. See end of Nomenclature.
N	= Speed of rotation, rpm
n	= Lining width coefficient = r/b . ($1 < n < 2$)
P	= Power, hp
p	= Pressure, psi
r	= Drum radius, in.
S	= Spring force, lb
T	= Torque, lb-in.
t_1	= Friction factor. See end of Nomenclature.
t_2	= Friction factor. See end of Nomenclature.
V	= Initial circumferential speed of drum, in. per min
v	= Circumferential speed of drum, fps
W	= Resultant pressure force, lb
α	= Angle between lining element and y -axis, deg
μ	= Coefficient of friction between lining and brake drum
ψ	= Angle subtended by brake shoe, deg

Heat Coefficient

$$h = \frac{\text{heat dissipation}}{\text{avg heat dissipation}}$$

$$= \frac{\text{heat dissipation}}{16,500 \text{ ft-lb/sq in.-min}}$$

Condition	h
Frequent operation or bad air circulation	0.333
Avg operation	1.0
Emergency or rare application	3.0

Friction Factors

$$t_1 = \frac{1 + \frac{a - 0.3e}{a + 0.3e}}{1 + \frac{a - \mu e}{a + \mu e}} \quad t_2 = \frac{0.3}{\mu}$$

$$= \frac{1.607}{1 + \frac{a - \mu e}{a + \mu e}}$$

μ	t_1	t_2
0.10	0.968	3.000
0.25	0.988	1.070
0.30	1.000	1.000
0.35	1.035	0.857
0.50	1.131	0.600

so that radial pressure is as uniform as possible. This is taken into consideration in the nomographs.

With the exception of drums which reach the ultimate values of circumferential speed and are maximum size, drums selected from the charts are minimum diameter. An increase of diameter for the same duties is permissible. This results in a reduction of the unit pressure and increases the wear life of the lining. It also reduces the size of the release solenoid.

Pressure at any point on the brake lining is proportional to the virtual radial displacement of the point. Radial pressure distribution can be represented by pressure circles. For the rigid-shoe brake, the distribution is as shown in Fig. 1. The x -axis is placed to pass through the post pivot, point Q , and the drum center, point O . The y -axis is perpendicular to the x -axis through the drum center.

Radial pressure, p , at any point, α deg from the

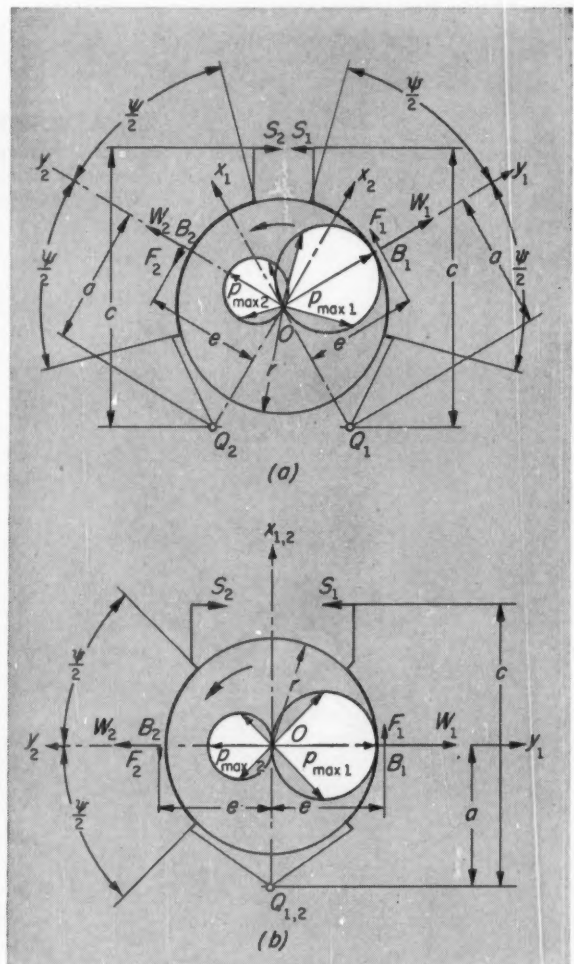


Fig. 2—Rigid-shoe brakes with two shoes. Brake shoes can be designed with separate pivots, a , or a common pivot, b .

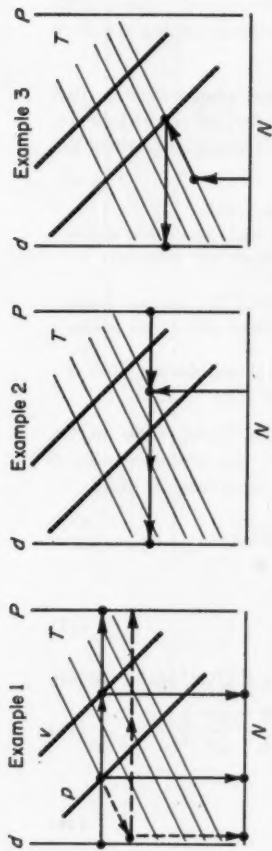
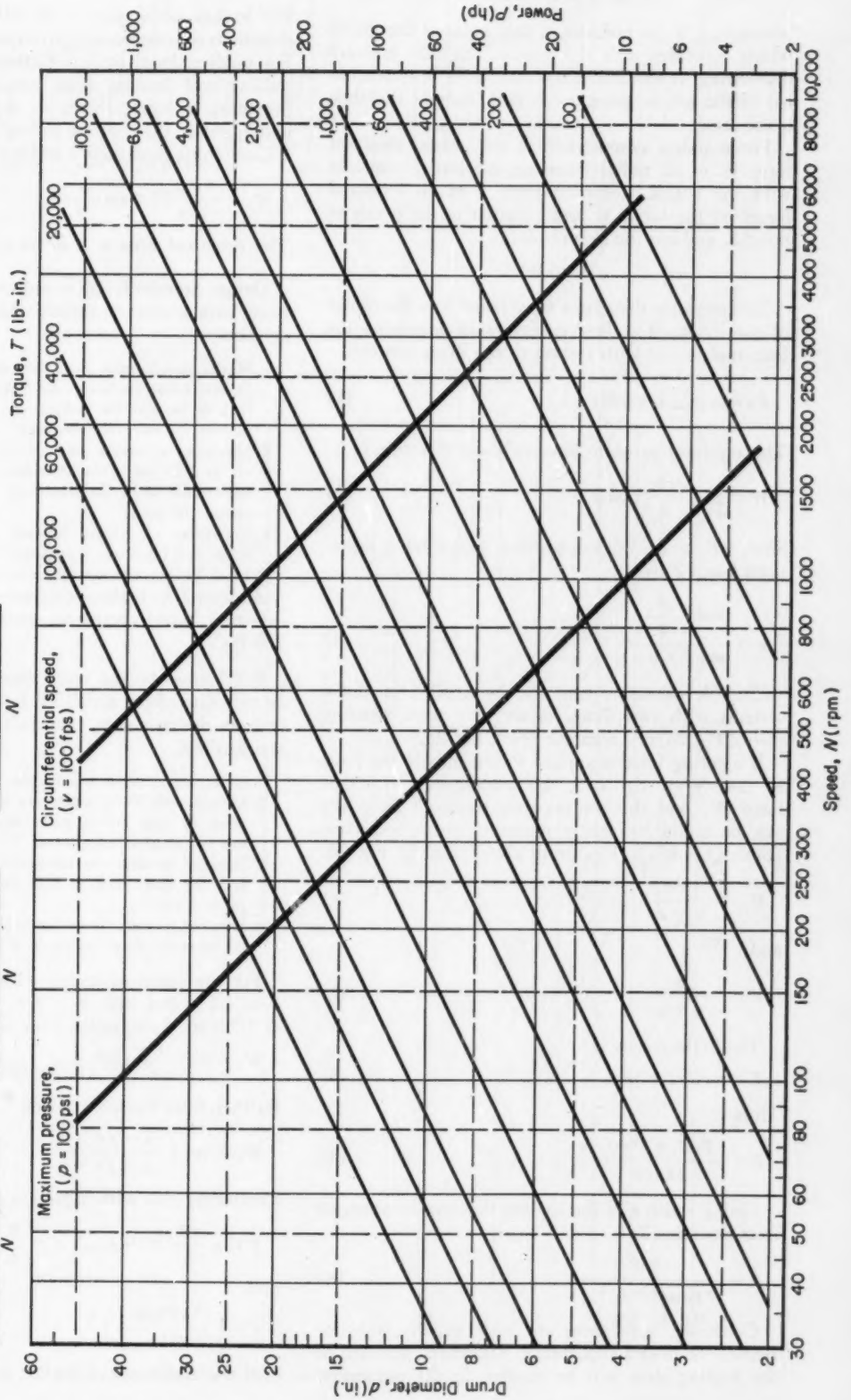


Fig. 3 — Brake-drum limits for average conditions. Coefficient of friction = 0.3, shoe angle = 90 deg, heat dissipation = 198,000 in.-lb./sq in. min, shoe width = drum radius.



y -axis, is (see *Nomenclature*):

$$p_a = p_{max} \cos \alpha$$

where p_{max} is the pressure at that point of the lining which coincides with the y -axis. The best pressure distribution is obtained when the lining is symmetrical to the y -axis; pressure at both ends of the shoe is the same.

For a lining symmetrical to the y -axis, resultant force W of all radial forces on the lining coincides with the y -axis. Resultant force F of all frictional forces on the lining is perpendicular to the y -axis at point B , and has the magnitude:

$$F = \mu W$$

To determine distance e from point B to the center of the drum, it is first necessary to determine the frictional torque with respect to the drum center:

$$F e = \mu p_{max} r^2 b \sin \frac{\psi}{2} \quad (1)$$

The resultant pressure force in the y -direction is

$$W = p_{max} \frac{r b}{2} (\sin \psi + \psi) \quad (2)$$

Since $e F = e \mu W$, substituting, and solving Equations 1 and 2 give

$$e = \frac{4 \sin \frac{\psi}{2}}{\sin \psi + \psi} r \quad (3)$$

This development can also be applied to brake systems with two shoes. Shoes may have separate pivots, Fig. 2a, or a common pivot, Fig. 2b.

If a spring force is applied to the ends of the posts so that $S_1 = S_2 = S$, the leading-shoe resultant force W_1 and the trailing-shoe resultant force W_2 can be found by taking moments about respective points Q_1 and Q_2 , Fig. 2a, or about point Q , Fig. 2b:

$$W_1 = \frac{S c}{a - \mu e} \quad (4)$$

and,

$$W_2 = \frac{S c}{a + \mu e} \quad (5)$$

The brake torque is

$$T = \mu e (W_1 + W_2) \quad (6)$$

Thus,

$$S = \frac{T(a^2 + \mu^2 e^2)}{2 \mu a c e} \quad (7)$$

Lining width b of the leading shoe can be obtained from Equation 2:

$$b = \frac{2 W_1}{r p_{max} (\sin \psi + \psi)} \quad (8)$$

Generally, both shoes are made equally wide for reasons of interchangeability. Maximum pressure of the trailing shoe will be smaller, in the proportion

$$p_{max2} = p_{max1} \frac{W_2}{W_1} = p_{max1} \frac{a - \mu e}{a + \mu e} \quad (9)$$

For brakes which are to be fully effective in both directions of rotation, this arrangement is satisfactory. For unidirectional brakes, maximum pressures of the trailing and leading shoes can be made equal by providing a lever system so that spring forces S_1 and S_2 obtain the required values.

Combining Equations 3 and 8 gives

$$W_1 = \frac{b r^2 p_{max}}{e} 2 \sin \frac{\psi}{2} \quad (10)$$

The projected area is $2 b r \sin (\psi/2)$.

Design Standards: Most industrial shoe brakes are lined with friction materials which have these characteristics:

1. Maximum allowable heat dissipation is 5500 ft-lb/sq in.-min when the brakes are frequently applied, 16,500 ft-lb/sq in.-min for average use, and 49,500 ft-lb/sq in.-min for rare (or emergency) use.
2. Maximum allowable pressure on brake lining materials is 150 psi. (Manufacturers of lining materials recommend that the maximum pressure should not exceed 100 psi.)
3. Coefficient of friction between lining material and drum is 0.1 for wet linings, 0.28 to 0.35 for asbestos-based linings, and 0.5 for cotton-based linings.

Additionally, brake drums are generally made from cast iron, which limits the circumferential speed to 100 fps.

Rigid shoe brakes with these characteristics can be calculated from simplified formulas or read directly from design charts, if certain design variables are standardized:

1. Shoes are symmetrical to the y -axis.
2. Linings with 90-deg angles are used. Small shoe angles result in large brakes, while excessively large arcs result in excessive lining wear.
3. Distance between the resultant of the pressure forces and the post pivot is 1.35 times the drum radius. ($a = 1.35r$)
4. Distance between the spring force and the post pivot is 2.7 times the drum radius. ($c = 2.7r$)

For the standard design with 90-deg shoe angles, $e = 1.1 r$, and with $b = r/n$, the projected area is $r^2 (2)^{1/2}/n$. Substitution into Equation 10 gives

$$W_1 = 0.91 \frac{r^2}{n} (2)^{1/2} p_{max} \quad (11)$$

Further, from Equations 4 and 5,

$$W_2 = W_1 \left(\frac{a - \mu e}{a + \mu e} \right) \quad (12)$$

Combining this with Equation 6 gives brake torque:

$$T = \mu \frac{r^3}{n} (2)^{1/2} p_{max} \left(1 + \frac{a - \mu e}{a + \mu e} \right) \quad (13)$$

and,

$$r = \left(\frac{n T t_1 t_2}{0.681 p_{max}} \right)^{1/3} \quad (14)$$

If the coefficient of friction is constant during the

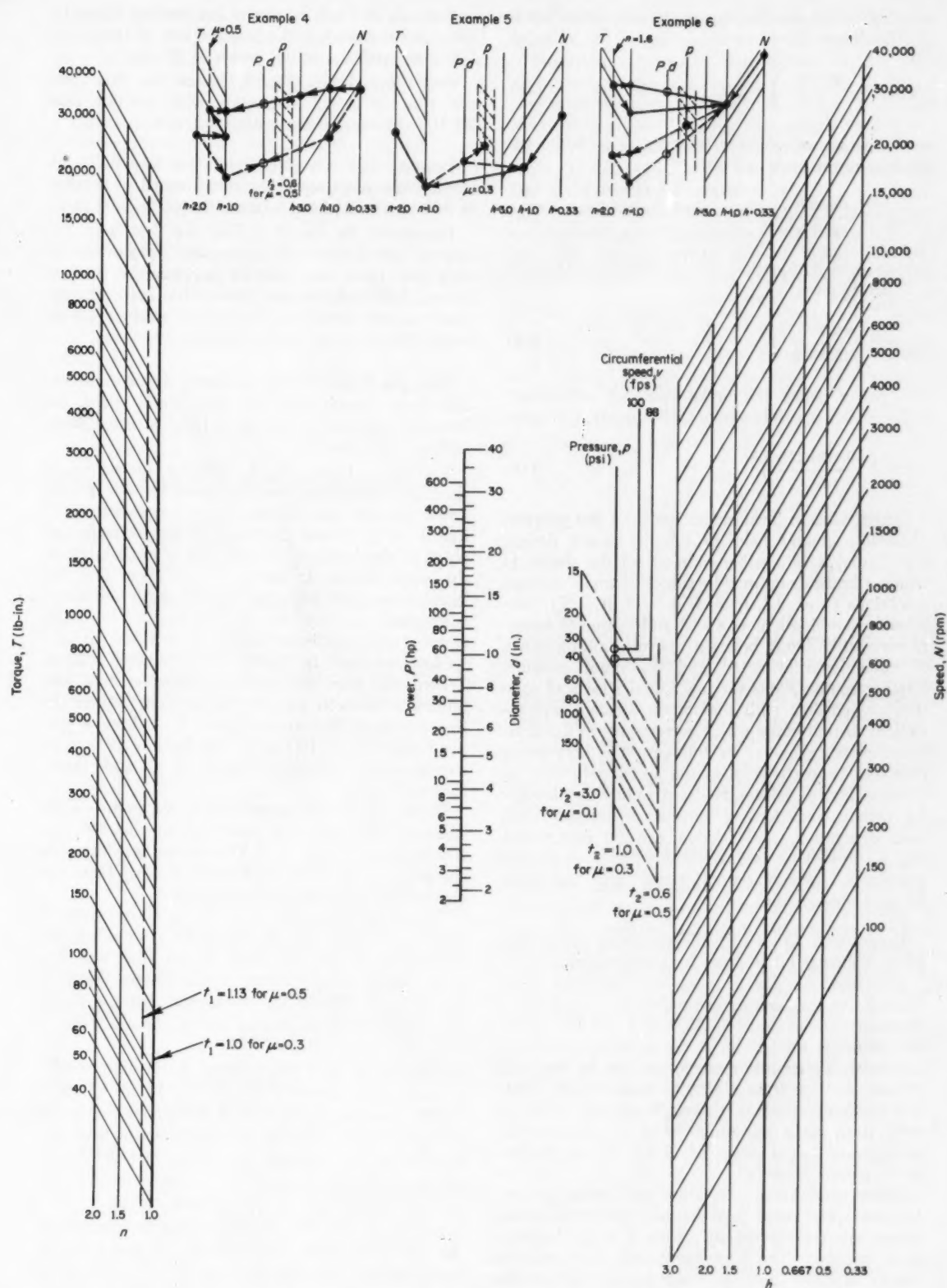


Fig. 4—Brake-drum limits for varied conditions.

stopping period, the limiting mean heat dissipation is 16,500h. Thus,

$$\mu p_{max} \left(\frac{V + 0}{2} \right) = (12) (16,500 h) \quad (15)$$

and, since the circumferential speed prior to the application of the brake is $2\pi rN$,

$$p_{max} = \frac{198,000 h}{\mu \pi r N} \quad (16)$$

Substitution of Equation 16 into Equation 14, with $\mu = 0.3/t_2$, gives

$$r = \left(\frac{n t_1 T N}{143,000 h} \right)^{1/2} \quad (17)$$

The power before the brake operation commences is $TN/63000$ hp. Substitution into Equation 17 gives

$$r = \left(\frac{0.442 n t P}{h} \right)^{1/2} \quad (18)$$

Design Charts: Two charts based on the previous discussion greatly help to simplify brake design. Fig. 3 makes it possible to read off the duties to which a brake drum may be subjected under average conditions ($\mu = 0.3$, $t_1 = 1$, $t_2 = 1$, $n = 1$). Permissible combinations of speed and torque or horsepower will be found between the two limiting curves of circumferential speed and maximum pressure. Further combinations for low initial speeds of rotation are possible with the torque constant and restricted to that value which corresponds to the maximum-pressure curve. In this case the horsepower decreases proportionally to the speed reduction.

From Fig. 4, minimum drum radius or diameter for various conditions of horsepower, torque, speed, heat dissipation, and friction can be determined. Fig. 4 can also be used to check whether or not the permissible circumferential speed and maximum pressure are exceeded.

Example 1: Determine the operating limits of a 10-in. diameter brake drum for average conditions.

SOLUTION: In Fig. 3, follow the line from 10-in. diameter to the limiting circumferential-speed curve. Maximum initial speed is 2300 rpm. At this speed, the torque is 1600 lb-in. If the speed of rotation is decreased, higher maximum torque can be obtained. Follow the line from 10-in. diameter to the limiting maximum-pressure curve. Maximum torque is 8500 lb-in. at a minimum speed of 420 rpm for a maximum initial power of 57 hp (follow the line to the power column).

Other combinations of torque and initial circumferential speed which give the same maximum horsepower are represented by points that lie between these extremes. The drum can handle the maximum torque of 8500 lb-in. at lower speeds (follow the diagonal line), but power will decrease. At 200 rpm, it is only 27 horsepower.

Example 2: Find the size of the smallest drum for average conditions, if the initial speed of rotation is 900 rpm, and the initial power is 25 hp.

SOLUTION: Using Fig. 3, follow the line from 900 rpm up to its intersection with the line from 25 hp. Minimum drum diameter is $6\frac{3}{4}$ in.

Example 3: For average conditions find the minimum drum diameter if the initial speed of rotation is 300 rpm and the maximum torque is 1000 lb-in.

SOLUTION: In Fig. 3, follow the line from 300 rpm to the 1000-lb-in. torque line. Since the intersection point does not lie between the limiting curves, follow the torque line to the limiting maximum-pressure curve and read 4.8 in. on the diameter scale. This is the minimum diameter.

Example 4: Determine the drum diameter to suit 225 lb-in. torque and 800 rpm initial speed, for frequent application. Lining material is cotton based with $\mu = 0.5$, and $b = r/2$.

SOLUTION: Using Fig. 4, find the intersection of the 225 lb-in. torque line and the n line for $n = 2$. Draw through the intersection a perpendicular to line $n = 1$. Follow the diagonal line through this point to the intersection with line $\mu = 0.5$. Draw the perpendicular to line $n = 1$. Then, find the intersection of the 800-rpm line and the h line which corresponds to frequent application, $h = 0.333$. Draw the perpendicular to line $h = 1$.

Now, connect the points on the n and h lines. Where the line intersects the diameter line, the minimum diameter can be read as 6 in. Where the line intersects the pressure-speed line, draw a perpendicular to the line $t_2 = 0.6$ for $\mu = 0.5$. The corresponding pressure is below 15 psi and, therefore, quite safe.

Further, draw the connection of the point on the diameter line and the point where the 800-rpm line intersects line $h = 1$. This connection intersects the pressure-speed line well below 88 fps. Thus, the circumferential drum speed is quite safe.

The required horsepower which corresponds to these conditions can be found by connecting the intersection of the 225 lb-in. torque line with line $n = 1$, and the intersection of the 800-rpm line with line $h = 1$. Where the connection cuts the power line, the required power can be read off as 2.9 hp.

Example 5: Find the required drum diameter for a brake if the torque is 100 lb-in., the initial speed is 200 rpm, the coefficient of friction of the lining material is 0.3, and average conditions of heat dissipation can be expected. Also, lining material should not be subjected to pressures in excess of 150 psi, and lining width is to equal drum radius.

SOLUTION: In Fig. 4, connect the intersection of the 100 lb-in. torque line and $n = 1$ line with the intersection of the 200-rpm and $h = 1$ lines. Since this connection does not intersect the diameter line, the resulting pressure is excessive. Therefore, con-

nect the intersection of the 100 lb-in. torque line and $n = 1$ line with the intersection of the 150-psi pressure and the $\mu = 0.3$ lines. This connection intersects the diameter line, and the required diameter is 2 in.

Check for circumferential speed by connecting the point on the diameter line with the intersection of the 200-rpm and $h = 1$ lines. This connection crosses the speed line well below 88 fps. Thus, the circumferential drum speed is quite safe.

Example 6: Determine the required brake drum radius if the torque is 5000 lb-in. and the initial speed of rotation is 4000 rpm. Ratio of drum radius to lining width is 1.6, the coefficient of friction is 0.3, and average conditions of heat dissipation are expected.

What is the maximum permissible torque for the

same conditions if the given value is too high; what is the initial power for these conditions?

SOLUTION: Find the intersection of the 5000 lb-in.-torque line and the $n = 1.6$ line in Fig. 4, and draw the perpendicular to the $n = 1$ line. Connect the intersection of the perpendicular and $n = 1$ line with the intersection of the 4000-rpm and $h = 1$ lines. Drum radius is 15 in., but the circumferential speed would be excessive.

For a 4000-rpm initial speed and a 100-fps circumferential speed, maximum drum radius is 2.8 in. and the limiting torque is 180 lb-in. The corresponding power can now be read off as 11.5 hp.

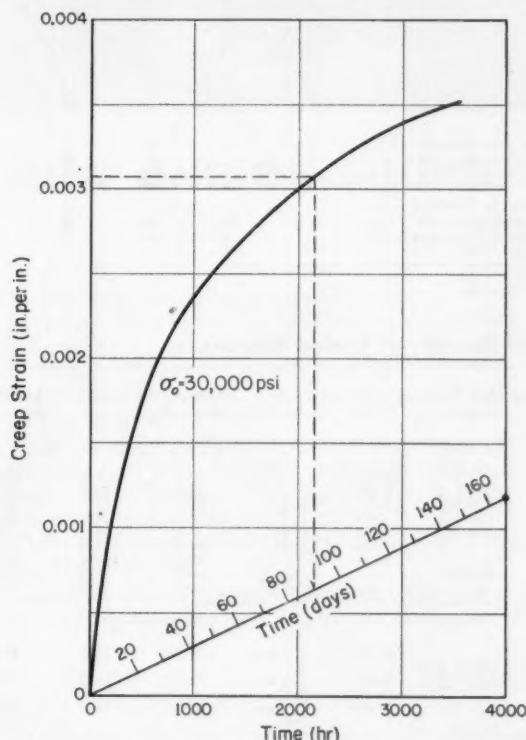
BIBLIOGRAPHY

1. Virgil Moring Faires—*Design of Machine Elements*, Third Edition, The Macmillan Co., New York, N. Y., 1955, pp. 462-482.
2. J. Hirschhorn—"An Analysis of the Forces and Pressure Distribution in Brake Shoes," *Engineering*, Vol. 173, April 4, 1952, p. 418.
3. J. Hirschhorn—"Design of External-Shoe Brakes," *Product Engineering*, Vol. 30, No. 48, Nov. 23, 1959, pp. 75-82.

Tips and Techniques

Conversion of Co-ordinates

The ordinate or abscissa of a curve can be converted easily to accommodate a desired change in units. An example of an abscissa change is shown below where the original units are hours and the



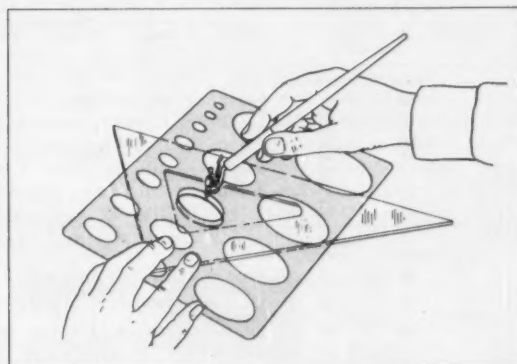
conversion is in terms of days.

A value near the high end of the scale is selected and equated to the new set of units (4000 hr = 166.7 days). A convenient scale, longer than the original, is then chosen so that 166.7 intersects the 4000 hr ordinate; a line is drawn from the origin to this point, and the scale is suitably divided.

Dash lines show the use of the new scale to find creep strain after 90 days.—JOHN R. SMITH, engineer, Bettis Atomic Power Div., Westinghouse Electric Corp., Pittsburgh, Pa.

LeRoy Circles and Ellipses

Easier, faster, and safer than a ruling pen or inking compass, a LeRoy pen can be used as shown to ink circles, ellipses, etc. on drawings. Simply place the template over the cut-out center of a triangle so that the template is clear of the paper, and ink the desired shape.—R. E. ENTLE, Technical Div., Good-year Atomic Corp., Portsmouth, Ohio.



Materials and design factors in Electrical Contacts

AN electrical contact is any body of material which initiates or terminates the flow of an electrical current when brought into or moved away from physical touch with another body of material. Preferably, the action is completed in minimum time and with minimum disturbance of circuit constants.

Ideal physical characteristics of electrical contact materials are:

1. High electrical conductivity, to minimize the heat generated incident to the passage of electrical currents.
2. High thermal conductivity, to minimize and dissipate this heat, plus any heat generated by arcing during circuit interruptions.
3. Nontarnishing and noncorroding, with a constant surface condition giving zero voltage drop across the contact surfaces in any atmosphere, at any ambient pressure, or in a vacuum.
4. Sufficiently hard, to withstand all mechanical wear indefinitely.
5. Completely inert to arc erosion, metal transfer, welding or sticking and having

CHILDRESS B. GWYN Jr.

Special Projects Engineer
Gibson Electric Co.
Delmont, Pa.

a very low if not zero vapor pressure.

6. Extremely low contact pressures.
7. Inherent ability to overcome all tendencies to bounce or chatter.

Kinds of contact materials include:

- Alloys, which ameliorate arc-induced wear or transfer.
- Sintered materials, which overcome high inrush current welding, lower rates of electrical and mechanical wear.
- Combinations of dissimilar materials, which produce a synergistic effect, whereby each material increases the effective-

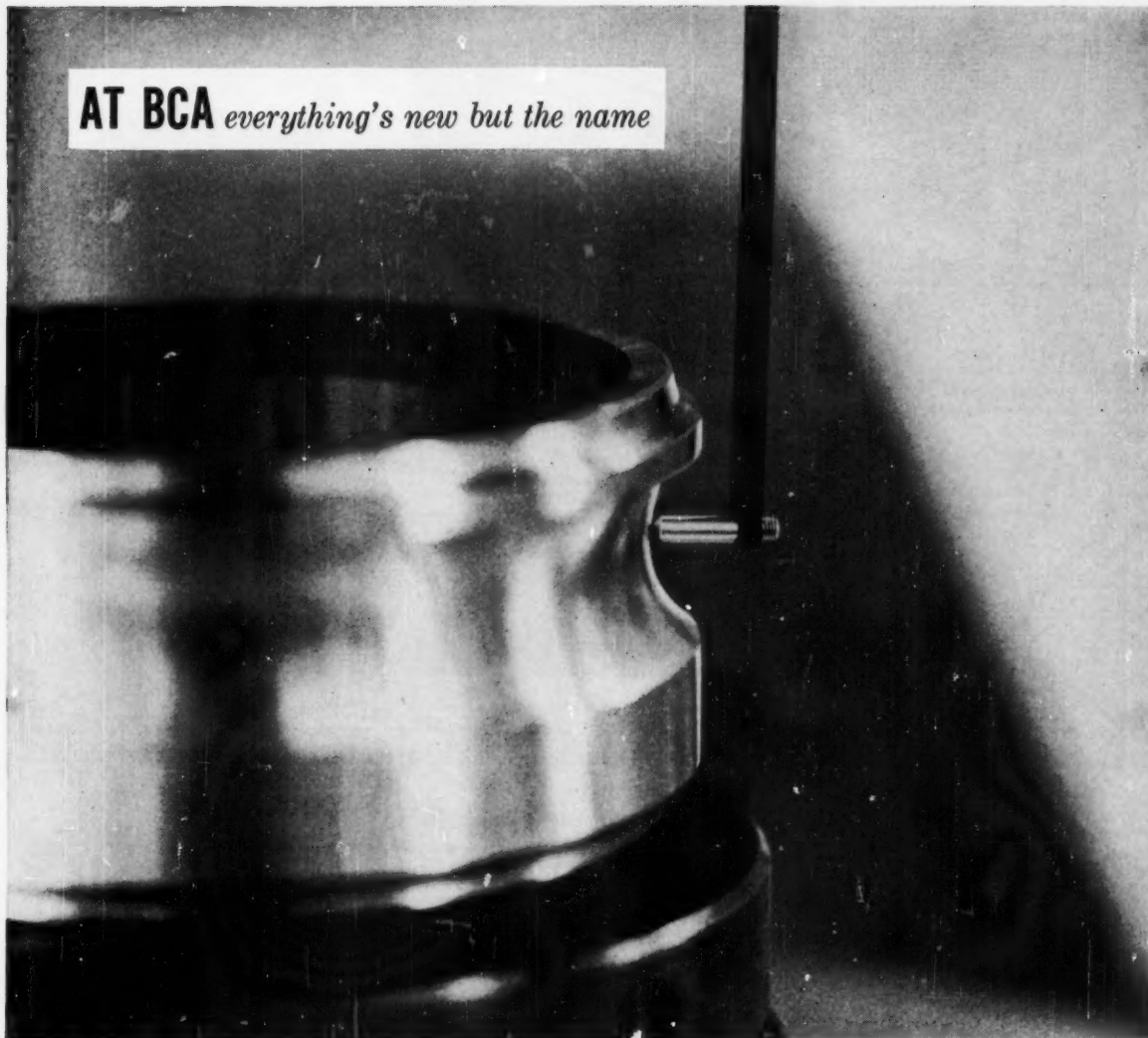
Table 1—Typical Material Code Numbers for Particular Applications

Type-of-Service Code Letters	A	B	C	D
Aircraft Equipment				
Control relays, light duty	78	80	76	95
Medium duty to 15 amp	77	54	19	78
Magnetos, low tension	15	115	114	117
Magnetos, hi tension	113	111	116	114
Bells and buzzers, to 120 v	78	80	83	87
Household Equipment				
Electric fry pans	83	78	84	73
Electric heating pads	78	80	102	83
Electric hot-water controls	71	77	2	83
Motors				
Fractional horsepower	80	78	84	1
Large motors, to 3 hp	77	54	74	96
Starter winding relays	77	54	78	80
Speed controls (governors)	15	78	80	11
Refrigerators, Electric				
Overload switches for	54	80	83	95
Motor starter switches for	55	78	80	54
Thermostats for	102	106	78	54

Table 2—Typical Properties and Sources of Coded Materials

Material Code	Type of Service	Composition by Weight (per cent)		Manufacturers and Their Codes						Rockwell Hardness (B)	Density (grams per cu cm)	Electrical Conductivity (% iacs)	
		Gibson	Baker	Mallory	Fansteel	Stackpole	Wilson	Gen. Plate					
	A	Silver	Tungsten										
1		90	10	W-2	251	D501	UB		S-112		23-33	11.20	90-93
2		80	20	W-4			UD		S-120		33-43	11.70	80-85
3		70	30	W-6			UF	FW-56		R-7	40-47	12.0	72-80
4		60	40	W-8			UH	CW-160			50-58	12.60	60-65
5		50	50	W-10	1152	50-S	UJ	FW-49	S-105	R-9	60-72	13.28	57-63
10		20	80	W-16	1117		UP		S-128	R-13	91-100	16.18	35-40
11		15	85	W-17			UQ		S-111		92-100	17.05	32-37
13		85	15	W-3			UC	FW-34			84-94	15.08	44-50
14		45	55	W-11	1118		UK				65-74	13.99	52-55
	A-B	Silver	Cadmium Oxide										
75		95	5	KA-1 and KB-1	2947	D-53 and D-53X			S-133	K-2 and S-2	27-45B	10.25	85-90
76		90	10	KA-2 and KB-2	2948	D-54 and D-54X	RJA	ES-77	S-81	K-4 and S-4	36-55B	10.15	75-85
77		85	15	KA-3 and KB-3	2945 or 2949	D-55 and D-55X	ROA		S-138	K-5 and S-5	30-45B	10.01	73-75

AT BCA *everything's new but the name*



NEW ONE-OF-A-KIND MICROGRAPH

draws pictures for bearing research

This greatly magnified stylus is drawing a picture of the microscopic imperfections in a bearing raceway . . . measuring each one to within a few millionths of an inch. The picture-on-tape which comes out of this specially modified micrological instrument is an important tool in BCA's research on ball bearing performance.

This is just one of the precision instruments in the Temperature-Humidity-Controlled Instrumentation Room which is the center of BCA research on bearings. The result of this program is revealed in on-the-job performance of BCA bearings. They roll dependably under heavy loads and all kinds of adverse conditions.

New testing facilities at the BCA laboratories also include specially designed equipment, often identical with equipment

in customers' plants. Here, BCA bearings are tested to exceed customer specifications *under the exact operating conditions experienced by the customer!*

BCA ball bearings are standard original equipment . . . replacement, too . . . for nearly every kind of industry. For example, automotive, earth moving, agricultural and machine tools. The wide line of ball bearing sizes and types, plus BCA's research and extensive new testing facilities, pays off for bearing users. Consider the performance record of BCA ball bearings the next time you purchase or specify bearings. For more information, or for assistance with bearings problems, contact Bearings Company of America, Division of Federal-Mogul-Bower Bearings, Inc., Lancaster, Pa.



**BEARINGS COMPANY
OF AMERICA**

**ball
bearings**

DIVISION OF
FEDERAL-MOGUL-BOWER
BEARINGS, INC.

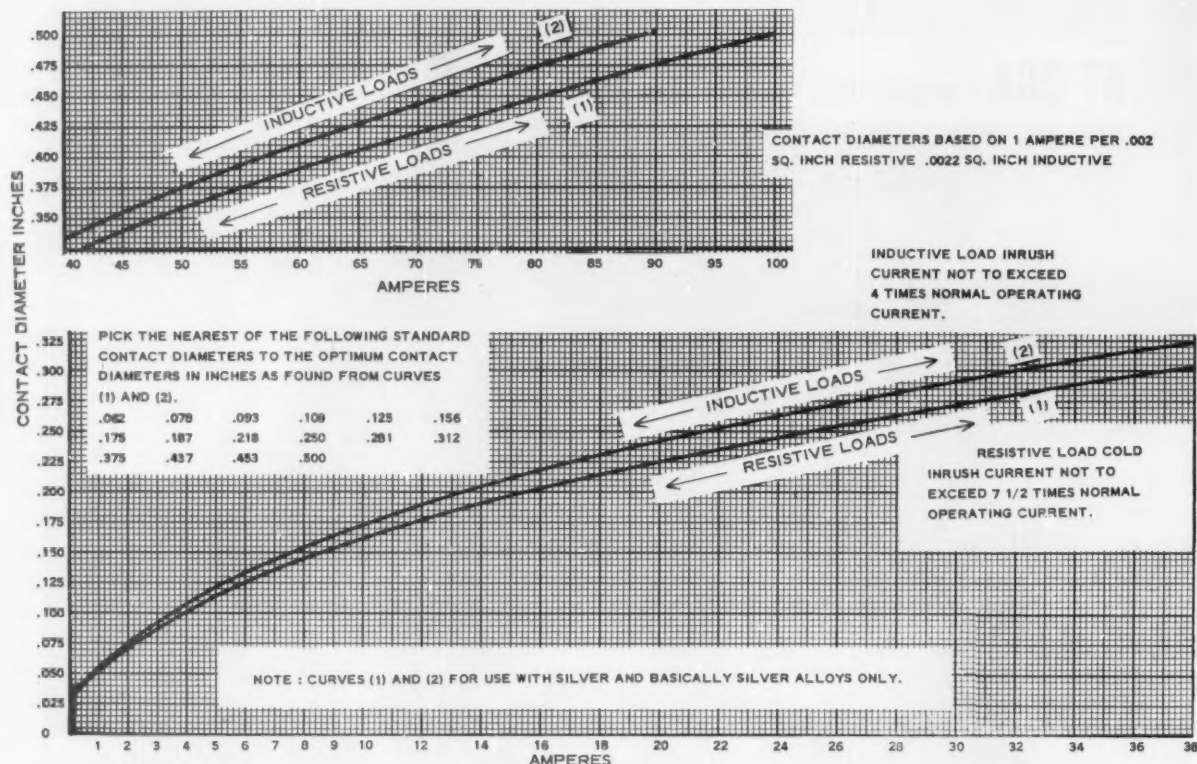


Fig. 1—Contact-diameter flow-rating chart.

Conditions:

1. Amperes indicated for 120-v ac 60 cycle. For 28-v dc, read currents directly from chart.
2. Amperes on 230-v ac 90 per cent that of 120 v. For 120-v dc currents, use 1/4 of ac ratings.
3. Amperes on 440-v ac 75 per cent of 120 v. For 230-v dc currents, use 1/6 of ac ratings.

4. Amperes on 660-v ac 55 per cent that of 120 v.

Procedure:

Locate flow rate on horizontal scale. Project upward to proper curve. From intersection, project to vertical scale. Compare vertical scale reading with table of standard contact diameters. Select standard diameter nearest to value determined graphically.

ness of the other.

According to composition, contact materials are:

1. Silver and basically silver alloys—the most universally used. Pure silver has the highest electrical and thermal conductivity of any of the materials in these groups.
2. Noble metals, comprised of gold, and the platinum family group, platinum, palladium, osmium, rhodium, iridium, ruthenium, and their alloys. All have the common property of substantial resistance to the effects of oxidation, corrosion, atmospheres, and humidity.
3. The refractory metal group, comprised of tungsten, molybdenum, rhenium. Basically, these materials have high melting points, and high resistance to electrical and mechanical wear.
4. Refractory metals and carbon. Combined by powder metal and/or infiltration techniques, they have high inherent electrical resistance.
5. Copper and its alloys. Pure copper is seldom used, but copper plus silver or cadmium is often a "must" for certain fields. One alloy has given excellent anti-

welding properties with a low over-all resistance drop.

Selection of materials for electrical contacts can be simplified by the use of devices such as Tables 1 and 2. As presented here, both are extracts of considerably longer and more comprehensive tabulations. When the application of a contact is known, Table 1 provides code numbers for as many as four different alloys, each of which is suitable for four types of service, respectively. The material code numbers are found in Table 2 which provides the compositions of alloys, other significant properties, and commercial sources.

Sizes of contacts can be determined from Fig. 1. This chart has been developed empirically by averaging the diameters of several hundred contacts reported as functioning satisfactorily under given loads, voltages, and circuit factors. The study which resulted in Fig. 1

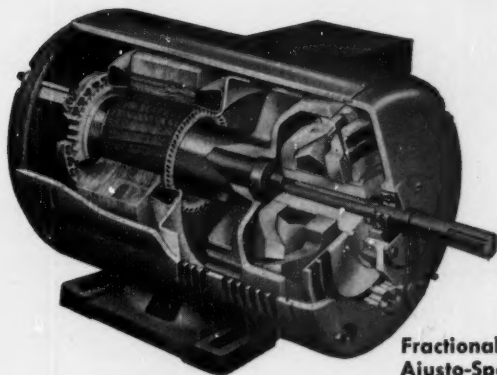
indicated that silver and silver-alloy contacts gave satisfactory service under conditions noted in the caption.

In making final contact selection, consider the effects, both individually and collectively, of various factors in the electrical circuit, and a number of related physical and mechanical factors. These include:

1. Normal and peak currents through the contacts?
2. Normal and peak voltages across the contacts?
3. Is the circuit to be controlled ac or dc? If dc, can the contacts be polarized? If ac, at what frequency?
4. Are the effective values of the circuit primarily resistive, inductive, or capacitive?
5. What is the normal operative pressure on the contacts when closed? Is there any "fritting" (dry mechanical rubbing action) on the contacts when closed?
6. What is the ambient, operational, and permissible maximum temperature range?
7. What is the surrounding atmosphere, or do the contacts operate in a vacuum?

Bring Your Speed Control Problems to

EDDY-CURRENT HEADQUARTERS



Fractional HP
Adjusto-Speed Drive



**Let Our Years of
Speed Control Experience
Go to Work for You!**

30 years ago Dynamatic pioneered the utilization of eddy-currents in industrial rotating equipment. Today, the Dynamatic Division of Eaton Manufacturing Company is the recognized leader in the development and production of eddy-current drives, couplings, brakes, and dynamometers—equipment which is solving production problems in every major industry.

In speed control applications, Eaton-Dynamatic Eddy-Current Equipment offers many exclusive advantages—stepless adjustable speeds from AC power, rapid response, wide speed range, quiet operation, low power loss, low maintenance cost, remote control, simple electronic or transistorized control.

Dynamatic Eddy-Current Equipment is available in sizes from 1/4 hp Adjusto-Speed Drives to heavy-duty couplings rated up to 20,000 hp—and larger.

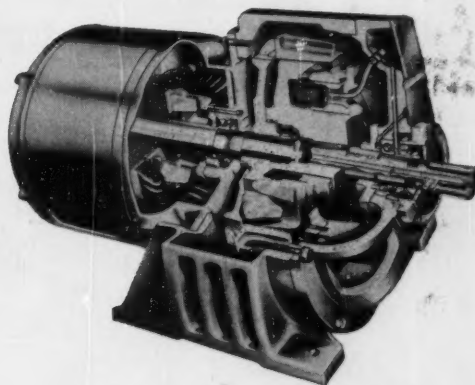
When you have a speed control or drive problem, bring it to "Eddy-Current Headquarters"—we can provide a simple, economical solution.

Write for Illustrated Descriptive Literature

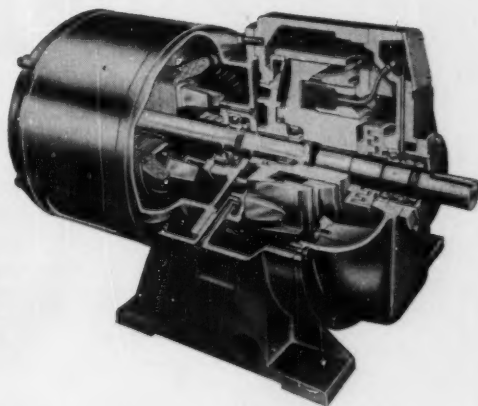


EATON

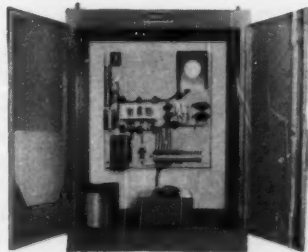
— DYNAMATIC DIVISION —
MANUFACTURING COMPANY
3122 FOURTEENTH AVENUE • KENOSHA, WISCONSIN



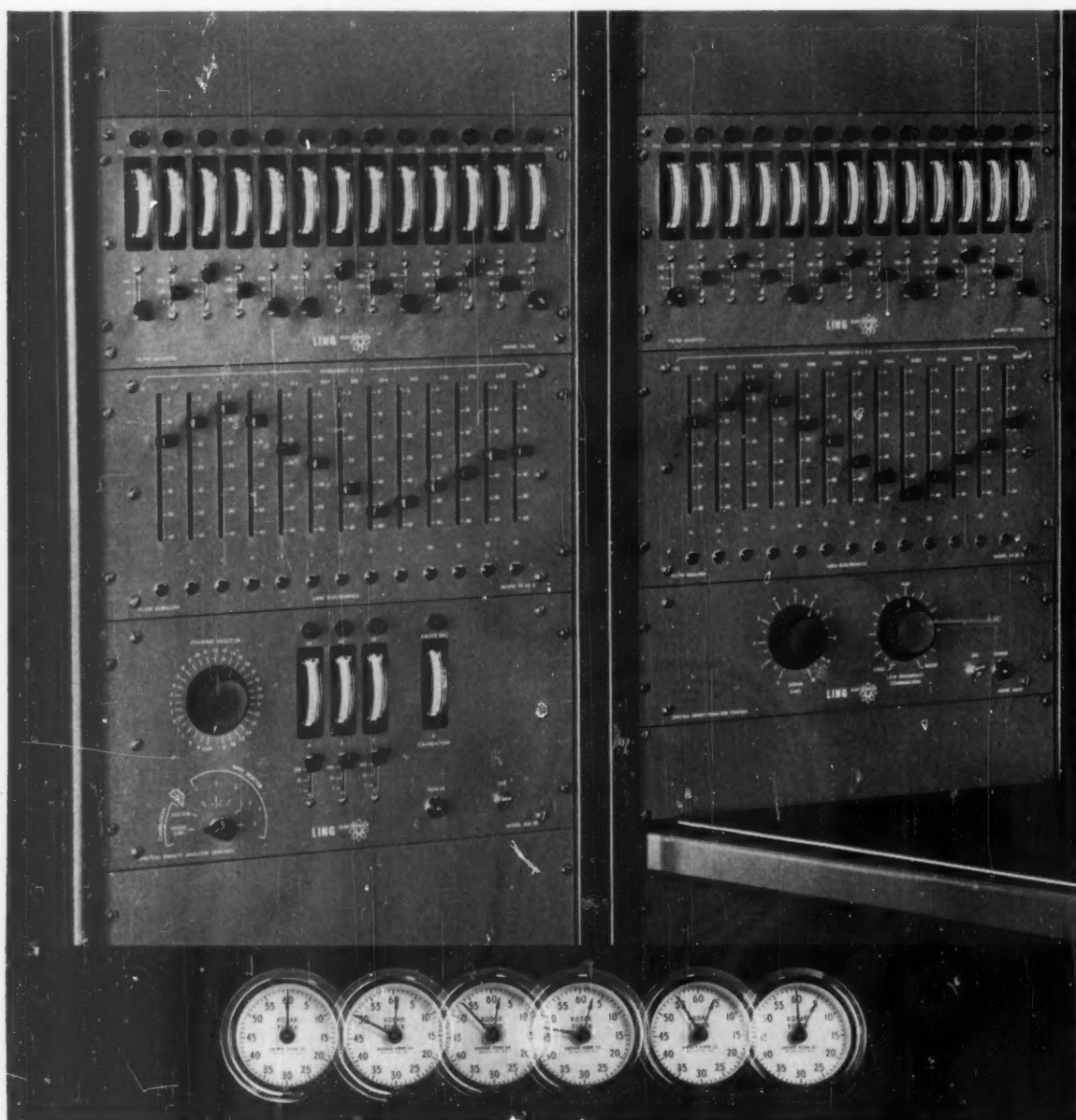
Air-Cooled Adjusto-Speed Drive



Liquid-Cooled Heavy-Duty Drive



Magnetic Amplifier (Transistorized)
Control



LING BREAKS THE RANDOM TEST TIME-BIND WITH A NEW FAST SET-UP

Now Ling brings you another breakthrough in random noise testing. Ling's new Equalizer-Analyzer system lets you set up a shaped input in minutes, analyze unknown variations at a glance and equalize spectrum shifts even while the test is in progress. The simplified controls of this remarkable system feature a series of separate adjustable attenuators which split the entire bandwidth of 10 to 2000 cps into segments of 100 cps or less, giving the operator independent control over each segment. Band-pass characteristics of the analyzer filters are matched to those of the equalizer, giving the operator a continuous picture of shaker acceleration output, calibrated directly in g^2/cps , segment by segment, for an analysis that is 30 times faster than the usual sequential scanning method. Corrections in energy distributions can be made in minutes simply by adjusting the filter attenuators. Enables fast set up without the tedious wait for slow types of analysis, gives you sure control and a correct-as-you-test system. For details, write for a copy of a recent paper on the subject by J. A. Ross, Vice President, Research and Development. And for electronics that help you get out of prototype into production *fast*, look to the leader—Ling Electronics. Dept. MD-3



L I N G
ELECTRONICS

A DIVISION OF LING-ALTEC ELECTRONICS, INC. • 1515 SOUTH MANCHESTER, ANAHEIM, CALIFORNIA • 120 CROSS STREET, WINCHESTER, MASSACHUSETTS

LING ELECTRONICS

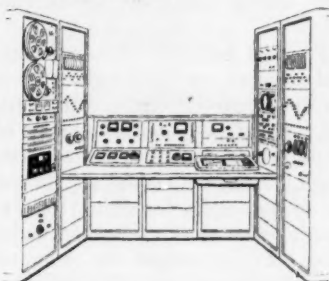
Like all Ling equipment, the ESD/ASD Equalizer-Analyzer is designed to speed your work, improve control accuracy, and reduce maintenance.

In the ESD/ASD system, for instance, there is less interaction between the controls than on equalizer systems which employ electro-mechanical filters.

Since the filters in the Ling system are passive, and a single amplifier is used, maintenance is much simpler than on units having a multiplicity of circuit components and amplifiers. This simplicity gives higher stability and uniformity of gain.

Further, by splitting the bandwidth into controllable segments of approximately 5% of the entire bandwidth, each segment can then be controlled within an accuracy of ± 2 db. Also available, is a 50-cycle bandwidth system, the ESD/ASD 40.

Ling pioneered the ESD/ASD—and over 20 units are now operating successfully in the field. Whatever your needs in high-power electronics—for vibration testing, acoustics or sonar—rely on Ling for truly advanced design.



LING CONSOLES, too, offer the most practical and orderly arrangement of components to simplify and speed your work. An entire system for automatic programming of sine-wave or random-wave tests can be housed in one compact, space-saving unit. Flexibility of design permits you to meet current needs or expand with the future.

L I N G

ELECTRONICS

HIGH-POWER ELECTRONICS FOR
VIBRATION TESTING • ACOUSTICS • SONAR

June 23, 1960

8. What is the ambient atmospheric pressure?

9. How often must the contacts function—100 times a second, once a day, once a year?

10. At what speed will the contacts make and break?

11. Maximum separation distance of the contacts at break?

12. How will the contact materials be assembled?

13. What are the allowable dimensions?

14. Will the contacts be subjected to chatter or bounce conditions?

15. Will the contacts rotate, slide, or wipe together?

16. Will the contacts be closed by a solenoid, magnetically, by springs, or other mechanical means?

17. Will the contacts normally operate in the open, in a cover, or in a hermetically sealed closure?

18. When not functioning, will the contacts normally be in an open or closed position?

19. What type of arc suppression will be used?

20. What price materials?

Speech No. 4, "Let's take the Mystery Elements Out of Electrical Contacts," presented at the Eighth National Conference on Electromagnetic Relays, Oklahoma State University, Stillwater, Okla., May, 1960, 7 pp.

materials

High-Temperature Corrosion Protection by Sprayed Metallic Coatings

Harvey S. Miller, New England Hard Facing Co.

High-temperature corrosion-resistant coatings produced by spray-metallizing. These coatings can be used at temperatures in the range of 600 to 4500 F. Suitable alloys consist mainly of a variety of compositions of iron, nickel and cobalt, in various proportions, to which are added in lesser amounts carbon, manganese, silicon, chromium, molybdenum, tungsten, niobium, titanium, and aluminum. Also, certain trace elements such as boron and zirconium are added. The resulting alloys become quite complicated to produce in many cases and also may present fabrication problems. Production economy and performance may both be achieved by putting a protective layer or bar-

DESIGN ABSTRACTS

rier on a less expensive material as long as the base material has the physical requirements at the elevated temperatures.

NACE Paper, "High Temperature Corrosion Protection with Spray Metallized Coatings," presented at the Sixteenth Annual Conference, Dallas, Texas, March, 1960, 9 pp.

Performance of Nonmetallic Structural Materials

William E. Dirkes, Materials Laboratory, Wright-Patterson Field, Ohio

Advantages of nonmetallic structural materials, particularly composite materials, and an approach for obtaining optimum properties from these materials. Included are glass-fiber-reinforced plastics and adhesives, sandwich-construction materials, ablation materials, and material systems.

A review of the method used to control glass-fabric-reinforced-plastics fabrication can serve as an illustration of the types of controls considered necessary for critical structural designs with nonmetallic materials.

A summary of the Air Force quality-control procedure is: 1. Establish minimum requirements for both the component materials and the composite structural materials. 2. Require manufacturer's instructions for use of component materials. 3. Require establishment of process controls which include use of the manufacturer's recommended procedure.

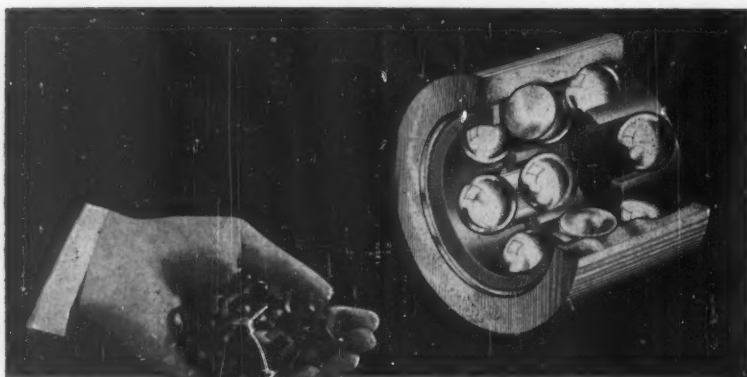
Use of this system does not guarantee optimum results for the designer, but it does insure that certain minimum standards are met.

ASME Paper No. 60-MD-10, "Increasing the Performance of Nonmetallic Structural Materials," presented at the Design Engineering Conference and Show, New York, May, 1960, 7 pp.

Deformation Resistance of Aluminum Alloys

R. R. Arnold, and R. J. Parker

Dependence of the extent of deformation on temperature and rate of deformation. Discussion pertains to commercially pure aluminum, three non-heat-treatable aluminum alloys and two heat-treatable aluminum alloys. Data are presented



**Ball retainers of antifriction
RULON A***
*add extra life and extra use
to antifriction bearings*

A well-known bearing manufacturer, after testing many metallic and non-metallic materials for use as ball retainers, standardized on Rulon A to insure far greater service life for their bearings. Dixon's "superTeflon" contributes many performance advantages in this application:

- Because of its low coefficient of friction, the Dixon-supplied retainers help keep frictional heat to a minimum, guarantee low starting torque, and smooth vibration-free performance.
- Due to its engineered reinforcing, Rulon A provides high resistance to wear and deformation under load . . . assuring precise spacing of balls.
- Because of high thermal and chemical

adaptability of Rulon A, the manufacturer now can offer bearings for the widest variety of service conditions. Rulon A retains its mechanical properties over -450°F to $+550^{\circ}\text{F}$ temp. range . . . has practically universal chemical inertness.

- The Rulon A retainers serve a dual role, having the ability to run completely dry—or to greatly extend performance with the use of lubricants.

As in the development of these efficient ball retainers, Dixon's research and engineering groups are ready to assist design engineers in the successful and profitable application of Rulon to their products. Knowledge of standard or special reinforcing additives plus a broad experience in the manufacture of molded, extruded, or machined parts make Dixon the ideal source for sleeve bearings, bushings, thrust bearings, wear strips, cam followers, relay pushers, torque control bushings, and many other mechanical and electrical components.

*One of Dixon's many modifications of Du Pont TFE Teflon

**Write for Engineering Data Sheets
on RULON**
DIXON Corporation, Bristol, R. I.

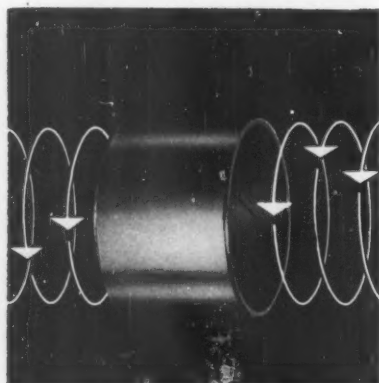
Dixon

Suppliers of basic shapes and fabricated parts in Rulon and Teflon



**Shafts run smoother
and longer on RULON
T-LINER BEARINGS**

Dixon's T-Liner Sleeve Bearing . . . with antifriction "floating" Rulon insert (modified TFE Teflon) . . . is designed for applications that require high wear resistance with no lubrication. Available from stock in 10 standard sizes for $\frac{1}{4}$ " to $1\frac{1}{4}$ " shafts. Bulletin 32-T gives full details on coefficient of friction (low!), chemical inertness (high!), and price (low!). Write **Dixon Corporation, Bristol, Rhode Island.** *Du Pont TM



Dixon

DESIGN ABSTRACTS

for strain rates within the range 1 to 30 in. per in. per sec, and temperatures varying from 300 to 550 C. The resistance to deformation of aluminum alloys in the hot-working range varies greatly. For example, the value for the high-strength aluminum alloy (5 per cent magnesium) at 300 C is about eight times that of commercially pure aluminum at 500 C. Higher-strength alloys are susceptible to thermal-softening effects, and resistance of these materials to deformation decreased after moderate reductions.

"Resistance to Deformation of Aluminum and Some Aluminum Alloys," prepared for the Journal of the Institute of Metals (Great Britain), Vol. 88, 1959-60, 5 pp.

techniques

Analysis of Control Systems By Analog Computers

William E. Sollecito, General Engineering Laboratory, General Electric Co.

Analysis and design of control systems can be broken down into three main parts: Problem definition, equation solution, and solution evaluation. In the area of equation solution, analog computers are invaluable.

Physical behavior of components and systems can be described by a set of integro-differential equations. The analog computer solves a set of simultaneous equations that are similar in form or "analogous" to the set of equations describing the dynamic behavior of the system under study. In this fashion the computer simulates the system. The computer solution, which is easily recorded on strip charts, reveals the transient and steady-state behavior of the system under study.

ASME Paper No. 60-MD-7, "Analysis of Control Systems by Analog Computers," presented at the Design Engineering Conference and Show, New York, May, 1960, 5 pp.

Response Time of Temperature Sensors

Marvin D. Scadron, Aero Research Instrument Co.

Techniques to determine: 1. How fast a thermocouple sensor will re-

spond to changes in temperature when it can transfer heat by conduction and radiation as well as forced convection. 2. What the time of response will be to "step" type process temperature changes. 3. How the time constant is affected by the choice of thermocouple wire.

Conduction and radiation heat transfer tend to speed up thermocouple response. However, if the time constant was predicted on the basis of forced convection heat transfer, it would be in error by about 25 per cent. The effect of radiation heat transfer seems to be more pronounced than conductive heat transfer.

Response of exposed or simple shielded thermocouples is essentially of first-order nature. The basic characteristic of a first order responding system is that it has no "inertia." The response of the temperature sensor is capable of executing abrupt changes in temperature with time. The response of the detector is dependent upon one independent parameter, the time constant.

SAE Paper No. 158H, presented at the SAE National Aeronautic Meeting, New York, April, 1960, 8 pp.

processes

Micro-Wire Welding

John H. Headapohl and Harley J. Orr, Hobart Brothers Co.

The small-wire gas-shielded welding process for thin material. Distinctive characteristics are:

1. Extremely small electrode wires from 0.020 in. to 0.045 in. in diameter.
2. Low current from 30 to 200 amperes dc, reverse polarity.
3. Low arc voltage from 15 to 24 volts.

Spatter is negligible and that which occurs is extremely fine and easy to remove. The shielding-gas flow required is 12 cu ft per hr, where 35 is specified for conventional CO₂ welding. A major advantage of the process is that the arc can be directed and localized in a corner or other small specific location.

This new process welds by transferring or depositing metal during cyclic short circuits rather than by

CARTONS · PACKAGING
DOZENS · COINS · FEET
PRODUCTION · YARDS
What do YOU
NEED to Count?
What kind of Counter
do YOU NEED?
DOZENS · COINS · FEET
PRODUCTION · YARDS



PIC CE600 Electric Counters!

- Count just about everything
- Are available in most every model
- Give DC reliability from AC

QUICK information about Counters! Compact, four-page brief catalog, illustrates, describes and prices complete line of counting instruments—including large, medium and small electric counters; the most complete line of actuating switches; stroke counters, revolution counters, batch counters, and coil winding counters. Send for your copy today!

Electric Counters
& Actuating Switches
Stroke Counters
Revolution
Counters
Batch Counters
Coil Winders



Manufacturers of Counters, Switches, Relays, Actuators and Automatic Valves

AUTOMATION CONTROLS DIVISION

GENERAL CONTROLS CO.

8078D McCormick Boulevard, Skokie, Illinois

Representatives and Distributors in Principal Cities of United States and Canada

A.O. Smith

has the horses!



800 to 1 hp favorites
for quiet operation,
low maintenance and
long-life service . . .

From the case of the
A. O. Smith Motor Man — a
complete stable of integrals
that include single-phase
models (1-5 hp) or polyphase
(1-800 hp). Also a team of
fractional-hp motors. All are sure
bets to give top performance
over the long, long haul.

And there's an A. O. Smith Motor
Man near you — chomping at
the bit to give you 24-hour action
on all parts and service orders.

COPYRIGHT 1960, A. O. SMITH CORP.

Through research  ... a better way

A.O. Smith

ELECTRIC MOTORS

Tipp City, Ohio
A. O. SMITH INTERNATIONAL, S.A.
Milwaukee 1, Wisconsin, U.S.A.

Circle 493 on Page 19

DESIGN ABSTRACTS

spraying metal across the arc. Short-duration short-circuits occur regularly at a rate of approximately 50 per second. During operation, the constantly fed electrode wire touches the weld pool. Immediate current surge is caused by the short circuit and resistance heating of the electrode wire. Melting, in turn, breaks the short circuit.

AWS paper, "Micro-Wire Welding," presented at the AWS 41st Annual Meeting and ASME Metals Engineering Div. Conference, Los Angeles, April, 1960.

Spinnability of Metals

Richard L. Kegg, senior research engineer, Cincinnati Milling Machine Co.

A new and economical test method for determining spinnability of any metal. A good criterion is the tensile reduction of area at fracture. Conclusions from use of the method are:

1. The ellipsoidal mandrel can be used to test the spinnability of materials.
2. The spinnability of most materials may be predicted from the tensile test reduction of area. This is possible through empirical relationship.
3. The average elongation determined from the tensile test cannot be used by itself to estimate spinnability.
4. Greater deformation is possible when spinning to a thickness less than required by the sine law; less deformation is possible with a thickness greater than sine-law requirements.
5. Greater reductions should be possible in the spinning of cones if a round-nosed mandrel is used and the thickness on this nose is controlled to obey the sine law at each point. This will eliminate bending and sudden changes in section which may be detrimental to the operation.

ASME Paper No. 60-Prod-3, "A New Test Method for Determination of Spinnability of Metals," presented at the Production Engineering Conference, Milwaukee, May, 1960, 6 pp.

Process Control By Electronic Sequencing

E. V. Crane, chief, Research and Development, and F. P. Fehn, senior electronics specialist, E. W. Bliss Co.

Application of electronic-sequencing principles to varied control functions for metalworking equipment. Discovering where control of this sort can be advantageous is a part

SAVE ON MATERIALS

NATIONAL RETAINING RINGS

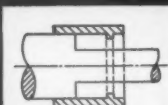
— improve products
and cut costs
substantially!

SAVE ON LABOR

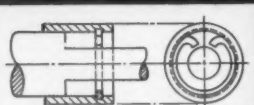
Efficient and economical NATIONAL Retaining Rings reduce weight, save space, simplify assembly and reduce production operations. Elimination of machining to form shoulders, threading, nuts and cotter pins are typical savings that can be effected. Ask NATIONAL for complete information and data on your particular applications, now!

FREE SAMPLES.

And descriptive literature will be sent promptly on request. Call or write to National, today.



— the old costly way



— the new NATIONAL way

The NATIONAL LOCK WASHER COMPANY

Serving Industry Since 1886

NEWARK 5, NEW JERSEY • MILWAUKEE 2, WISCONSIN

of the problem.

Servo control is perhaps the key idea. But the control of large masses and forces with ever smaller and smaller currents and components is only a part of the idea. More important is the almost human weighing and evaluating of the changing circumstances, and making the needed compensations from instant to instant.

Hydraulic circuits have much in common with electrical circuits, and are interchangeable in many respects for servo purposes. Giant tube-reducing machines are perhaps the largest servo-controlled hydraulically actuated machines in the country. A rolling-mill housing assembly weighing 150 tons must be reciprocated adjustably up to 6 ft, at speeds up to 30 strokes per min. By reason of flywheel energy storage, up to 4000 hp instantaneous peaks were developed on each reversal. The hydromechanical feedback linkage to the pump servo-valve combines instantaneous reports of mill position, pump position, and pressure changes with the time-stroke references to produce a substantially harmonic response.

ASME Paper No. 60-AUT-1, "Metal-Forming under Electronic Sequencing," presented at the Joint Conference on Automatic Techniques, Cleveland, April, 1960, 8 pp.

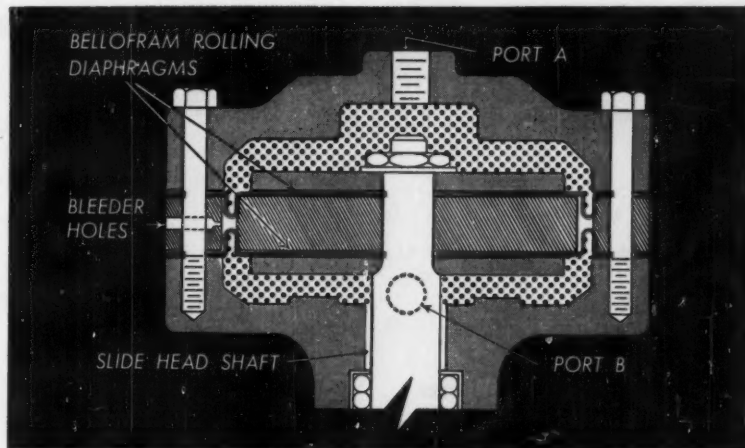
mechanical

Design Procedure For Thermocouple Probes

Laurence B. Haig, Engineering Development Dept., Research Laboratories, General Motors Corp.

An analytical procedure for the design of thermocouple probes for the accurate measurement of gas temperatures under steady-state conditions. Basic heat-transfer concepts are used in the design of the probe envelope for the thermocouple junction to provide an environment which is conducive to accurate gas-temperature measurement. The design procedure is comprised of the following steps:

1. Ascertain the maximum allowable temperature-measurement error.
2. Determine the approximate gross environmental conditions.



Air pressure entering double-acting cylinder at Ports A and B actuates slide head shaft, which controls positioning of upper electrode. Sensitive low inertia response is achieved by two frictionless Bellofram Rolling Diaphragms. Bleeder holes maintain a pressure differential.

Frictionless Rolling Diaphragms Insure Fast Follow-up for Welder

PROBLEM: To design, for use in an automatic welding machine, a pneumatic actuator for positioning the upper electrode in response to expansion or contraction of the weld nugget. Sensitive, frictionless movement was mandatory to provide instantaneous reaction to momentary changes in nugget dimensions.

SOLUTION: Federal Machine & Welder Company's designers specified a double-acting air cylinder with two Bellofram Rolling Diaphragms, each molded from a dacron fabric impregnated with a nitrile elastomer.

With no mechanical spring gradient, no break-out friction effects, and low hysteresis, these rolling, non-porous membranes instantly translate pressure changes into movement of the electrode control head. Although very sensitive to pressure variations, they are capable of sustaining high working pressures, because the force experienced on the narrow convolution is only a small fraction of the total force applied over the effective pressure area.

Operating between wide temperature ranges, these Bellofram Rolling Diaphragms provide a flex life of millions of cycles, yet do not

require lubrication or close machine fits for piston and cylinder.

Bellofram Rolling Diaphragms are free positioning and friction-free. They roll off the piston sidewall and onto the cylinder sidewall in a smooth, continuous motion.

WHAT IS YOUR PROBLEM?

If conventional bellows, O-rings, cup packings, etc., fall short of your requirements, Bellofram Rolling Diaphragms may be the answer. Special types can be designed for use with almost any gas or fluid in actuators, pumps, instruments, seals, accumulators, fluid dampers, etc.

OPERATING LIMITS

Operating Pressures: 1 inch H₂O to 500 psi (up to 1200 psi in some cases).

Operating Temperatures: -85°F. to +550°F. (from -120°F. to +700°F. in some cases).

Cylinder Bore Sizes: .25 to 12 inches.

Effective Pressure Area: .028 to 108 square inches.

Total Stroke Capabilities: .01 to 12 inches.

Sidewall Thickness: .008 to .035 inches.

Send for free literature

nothing rolls like a

Bellofram®

rolling diaphragm

BELLOFRAM CORPORATION, 32 BLANCHARD RD., BURLINGTON, MASS.

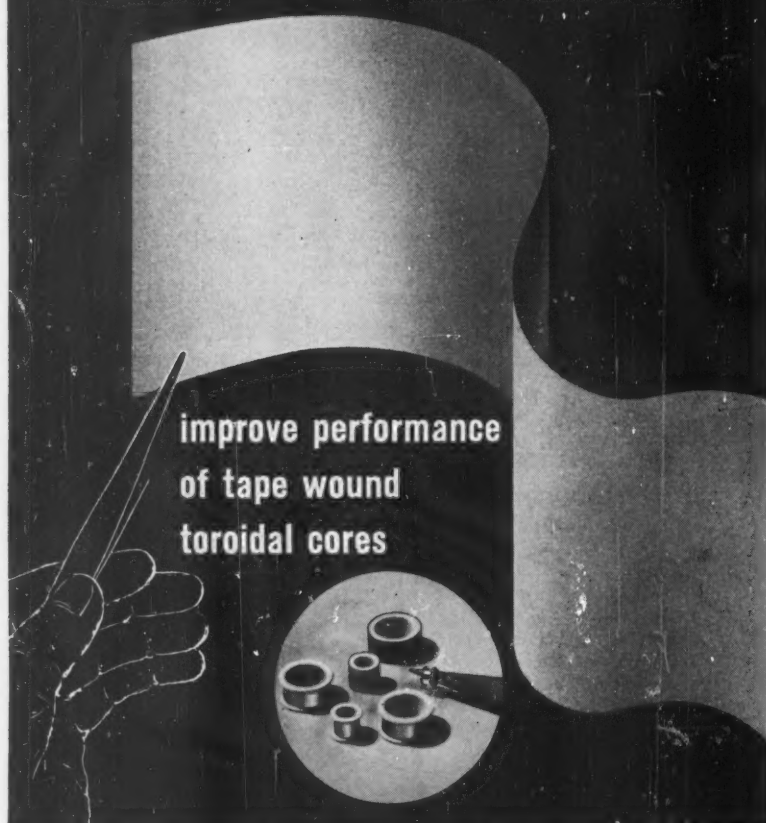
Browning 2-2100

Mission 3-9000

Teletype No. Burl., Mass. 166

©Reg. trademark U.S.A. and foreign countries • Bellofram Rolling Diaphragms are protected by U.S.A. and foreign patents.

magnetic alloys in ultra-thin strip...



improve performance
of tape wound
toroidal cores

Toroids that generate lower heat and higher efficiencies and provide more uniform performance are another advancement made possible by ultra-thin magnetic alloy strip from Precision Metals. This unique material—now available in production quantities—can be supplied in virtually any of the high magnetic permeability alloys such as 4-79 Moly Permalloy, 50-50 grain-oriented nickel iron and Muvar®.

Precision Metals strip and foil is cold rolled in thicknesses from .010" to .0001" and can be furnished slit to tightest dimensional tolerances. Note these other important advantages:

uniform magnetic properties
dimensional uniformity

extremely close tolerances
excellent surface characteristics

To meet specific requirements, Precision Metals can furnish custom alloys to your specification in the form you need. Write today for fully illustrated facilities booklet MD-6.



HAMILTON

WATCH COMPANY / Precision Metals Division

★® Lancaster, Pennsylvania

Regional
Representatives

COREY STEEL COMPANY • Chicago, Illinois
FAGERSTA STEELS PACIFIC, INC. • Los Angeles, California

DESIGN ABSTRACTS

3. Compute the total error and error distribution of a bare wire thermocouple under the gross environmental conditions.
4. Determine the local environment necessary to reduce the total error to the specified limits.
5. Select an envelope which will provide the desired internal velocity, radiation, and conduction conditions.
6. Calculate the errors resulting from the prescribed local environment and compare them to the accuracy requirements. If the total error is not acceptable, steps 5 and 6 should be repeated.

SAE Paper No. 158C, "A Design Procedure for Thermocouple Probes," presented at the SAE National Aeronautic Meeting, New York, April, 1960, 15 pp.

Designing Products For Automatic Assembly

Robert L. Esken, Autometrology Section, Sheffield Corp.

Problems encountered in designing products for automatic assembly. Of the five senses of a human being, sight and touch are used in hand-assembly operations. In designing machines for automatic assembly, these senses must be copied, in varying degrees, in mechanical, electrical, and electromechanical mechanisms.

The degree to which automatic assembly can be used depends, in part, on the ability of the product designer to incorporate into the design of each component characteristics for mechanical conveying, feeding, positioning, and fitting.

ASME Paper No. 60-MD-12, "Designing Products for Automatic Assembly," presented at the Design Engineering Conference and Show, New York, May, 1960, 5 pp.

hydraulic

Current Status of Hydraulic Pumps and Some Trends

Edward I. Brown, director of engineering, Machinery Hydraulics Div., Vickers, Inc.

Forecasts in the aeronautical, mobile, and industrial equipment fields. In the aero field, system pressures will rise to 4000 psi and temperatures to 750 F. Equipment must operate with fire-resistant fluids and synthetics because of the high temperatures. Speeds of small piston

pumps will increase to 24,000 rpm. Pump power requirements will increase to above 2000 hp.

In the mobile field, hydrostatic transmissions will be developed and used on off-the-road machinery because of higher efficiency and better control than hydrokinetic transmissions. Mobile auxiliary system pressures may rise above the 2000-psi range and pump speeds should exceed 4500-rpm. Central hydraulic systems look promising for both off-the-road machinery and automotive equipment. Mobile equipment will become more sophisticated with controls such as electrohydraulic servo valves.

In the industrial field, there is already a growing trend toward the use of fire-resistant fluids in hazardous applications. This trend will receive increasing emphasis with the use of lower cost fluids such as the water emulsion type. No doubt, machine tools will continue the trend toward the use of electrohydraulic servo systems. Hydraulic adjustable-speed drives will gain with respect to electrical and mechanical variable-speed drives because of better control.

ASME Paper No. 60-MD-5, "Current Status of Hydraulic Pumps and Some Trends," presented at the Design Engineering Conference and Show, New York, May, 1960, 12 pp.

TO OBTAIN COPIES of papers or articles abstracted here, write directly to:

ASME—American Society of Mechanical Engineers, 29 West 39th St., New York 18, N. Y., papers 40 cents to members, 80 cents to nonmembers.

AWS—American Welding Society, 33 West 39th St., New York 18, N. Y.

Eighth National Conference on Electromagnetic Relays, conducted by National Association of Relay Manufacturers and the School of Electrical Engineering, Oklahoma State University, Stillwater, Okla.

Journal of the Institute of Metals, 17 Belgrave Square, London S.W. 1, England.

NACE—National Association of Corrosion Engineers, 1061 M & M Bldg., Houston 2, Texas.

SAE—Society of Automotive Engineers Inc., 485 Lexington Ave., New York 17, N. Y.; papers 50 cents to members, 75 cents to nonmembers.

Maxitorq

STANDARD

floating disc

single and double clutches
or brakes

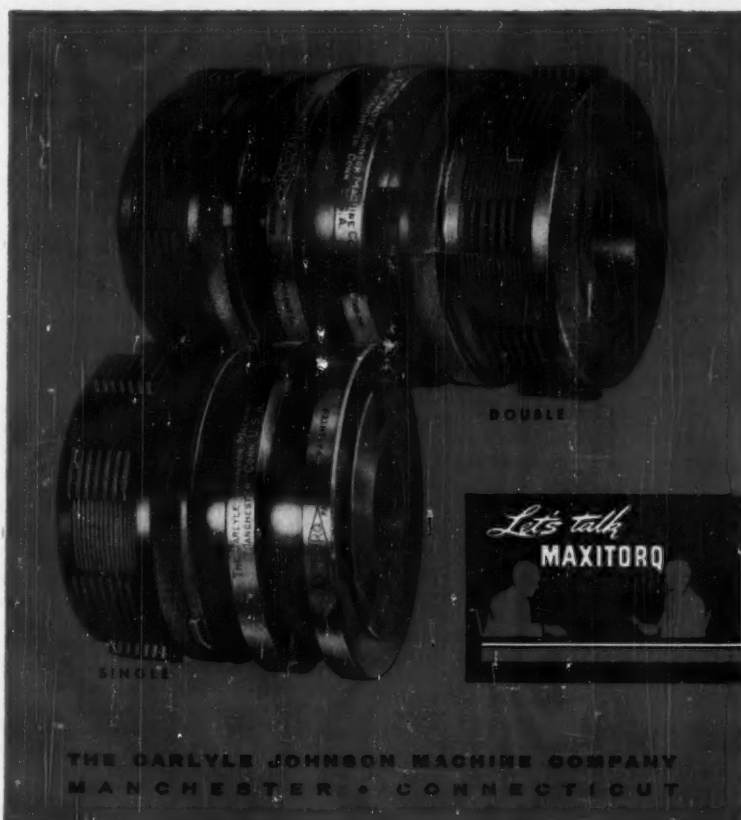
DESIGN PRINCIPLES OF THE 3 BASIC TYPES

The Maxitorq Clutch is completely assembled on the clutch body and shipped ready to slip onto a shaft. Separator springs... an outstanding feature... assure the advantages of truly floating discs. Used between each pair of inner discs, they spread them endways with an accordion action so that light can be seen between all discs when the clutch is in neutral. The floating disc feature makes certain that there's no drag... no abrasion... and consequently no heat when the clutch is in neutral.

A locking plate on the disc end of each clutch (two on the double types) locks all discs against tension developed by the separator springs. Manual adjustment is made by raising the lock spring, then turning the adjusting ring to give the desired shifting pressure.

Note that assembly adjustment and take-apart are all manual... no tools required.

Standard Maxitorq Clutches are available in single and double types, wet or dry... also in pulley and cut-off coupling types. Capacities to 15 h.p. at 100 r.p.m. Write Dept. MD for bulletin today.



Helpful Literature for Design Engineers

For copies of any literature listed,
circle Item Number on Yellow Card—page 19

Bolted Fastener

One-page Data Sheet describes Cam-Bolt, a fastener for use where the strength of a bolt is required but where fast opening and closing is desirable. Unit is pictured, and features are presented. Simmons Fastener Corp., North Broadway, Albany 1, N. Y.

Circle 641 on Page 19

Heavy Tungsten Alloys

New bulletin describes heavy tungsten alloys, with densities of 17 to 18.5 grams per cu cm. Properties, applications, fabrication methods, and available sizes and shapes of three grades are given. Engineering service and facilities are also offered in applying the materials. 8 pages. Kennametal Inc., Latrobe, Pa.

Circle 642 on Page 19

Pressure-Sensitive Tapes

Temp-R-Tape brochure provides information on ten high-temperature, pressure-sensitive Teflon, glass fiber, and silicone-rubber tapes. Each tape is analyzed individually as to construction and recommended uses. Typical design features and physical properties are also presented. 6 pages. Connecticut Hard Rubber Co., Dept. TRT, 407 East St., New Haven 9, Conn.

Circle 643 on Page 19

Electronic Hardware and Resistors

New pocket-sized catalog presents information on a complete line of electronic hardware and resistors. Diagrams and specifications are furnished for the various items. Line of wire-wound resistors is available from stock to fit all applications. Price lists are included. 96 pages. Sterling Precision Corp., Instrument Div., 17 Matinecock Ave., Port Washington, L. I., N. Y.

Circle 644 on Page 19

Copper-Clad Laminates

Technical information on copper-clad laminates is given in Data Sheet 8-1A. Bulletin lists advantages of copper-clad laminates in the production of printed circuits. Tables provide complete specifications and general information on sizes, thicknesses, tolerances. 4 pages. Taylor Fibre Co., Norristown, Pa.

Circle 645 on Page 19

Molded Packing

Technical Information Bulletin UR-360 presents a detailed description of U-shaped molded packing, the Palmetto U-Ring.

Features and advantages of the ring are described, and sealing operation is explained, aided by dimensional cutaway sectional views and schematic diagrams. U-Rings obtainable are listed and described as to style numbers, compositions, temperature ranges, and services. Complete specifications are provided. 4 pages. Greene, Tweed & Co., North Wales, Pa.

Circle 646 on Page 19

Hydraulic Cylinders

Hy-Power hydraulic cylinders (oil) and piston-type accumulators are described and pictured in new bulletin. Large cutaway drawings of the two major types are provided, with specifications given for the various sizes and models in each type. Tables provide information on mounting plates, rod eyes, rod ends, capacities, fluid velocities and pressure lines, and on accumulators. 16 pages. Cleveland Hydraulic Co., 5055 Richmond Rd., P. O. Box 7105, Cleveland 28, Ohio.

Circle 647 on Page 19

Manganese Steel Wear Parts

Roll-Man manganese steel, available in standard and new standard-prehardened types, is described in new folder. Wear parts work-harden to provide long life. Specifications for the two types of manganese steel are given. 4 pages. Manganese Steel Forge Co., Richmond Street & Castor Avenue, Philadelphia 34, Pa.

Circle 648 on Page 19

Submersible Sump Pump

Low-cost, easy-to-install submersible sump pump of corrosionproof canned construction is described in new two-color Dynasump Model 450 D Catalog. Large cutaway drawing illustrates important features. Material on recommended piping is provided, and performance data are given. 4 pages. Fostoria Corp., Dept. 15, 1200 N. Main St., Fostoria, Ohio.

Circle 649 on Page 19

Plastic Shapes and Parts

Form AD-177 provides information on Teflon, nylon, Delrin, CTFE, and other industrial plastics. It includes stock shapes, machined parts, and molded parts. Chart of comparative mechanical and electrical characteristics is included, and standard sizes of the plastic and plastic products are given for each item. Information on facilities is also included. 16 pages. Garlock Inc., U. S. Gasket Co. Div., Camden 1, N. J.

Circle 650 on Page 19

MAJOR MERGER IN SWITCH INDUSTRY

Controls Company of America
Merges Hetherington Div. With
Electrosnap Corp. to form
New Control Switch Division.

One of the precision switch industry's most complete product lines has come into existence with the announcement by Louis Putze, President of Controls Company of America, Schiller Park, Ill., that its subsidiary Hetherington, Inc., has been merged with Electrosnap Corporation, Chicago. The Electrosnap organization was recently merged with Controls Company of America.

"This merger is important to switch users," Mr. Putze stated, "because it combines the strengths of both companies."

WHAT'S IN IT FOR YOU?

You may now select from the industry's most versatile and complete line of precision snap-action switches, indicator lights, push-button switches, toggle switches, Switchlites, and environment-free limit switches. You can now make broader product groupings for greater quantity discounts. With this new single source, you will now deal with just one sales engineer for all your switch needs.

Three plant locations—Folcroft, Pa., Chicago, Ill., and El Segundo, Calif.—will provide regional engineering and manufacturing facilities to speed delivery and service.

Local sales offices with factory-trained personnel have been set up to provide on-the-spot application engineering in all major markets. An expanded nation-wide distributor organization will assure you of immediate delivery from local sources.

ELECTROSNAP
HETHERINGTON

CONTROL SWITCH
DIVISION
CONTROLS COMPANY OF AMERICA

4218 W. Lake Street • Chicago 24, Illinois
Telephone: VAn Buren 6-3100 • TWX No. CG-1400



NEW HiPAC PRECISION SWITCHES

Series S2A



take on *high current*
in control and indicating
circuits



These new HiPAC Precision Switches represent the latest refinements of the switch-makers' art. Compact and precision made in every detail, these small high-current switches provide carefully controlled force and movement characteristics for unsurpassed repeatability in critical applications. One-piece blade actuators of selected beryllium copper operate against solid silver contacts to give long, stable mechanical and electrical life with uniformly low contact resistance.

Here's a capsule run-down on the new Series S2A Switches: rated at 20 amps., 125/250 volts ac, 1 and 2 horsepower ac; U.L. Inspected; SP-DT

circuit; unusually rigid ammonia-free phenolic case; interchangeable with other precision switches of equivalent ratings; built-in safety limit to prevent over-travel damage to blade; molded-in barriers to provide long creepage paths and positive separation between terminals and leads.

HiPAC Precision Switches are available with any of eight actuators. Prompt delivery of samples may be obtained from over 50 leading electronic parts distributors—use part numbers shown above to order. For complete specifications, write for Bulletin S-9.

ELECTROSNAP
HETHERINGTON

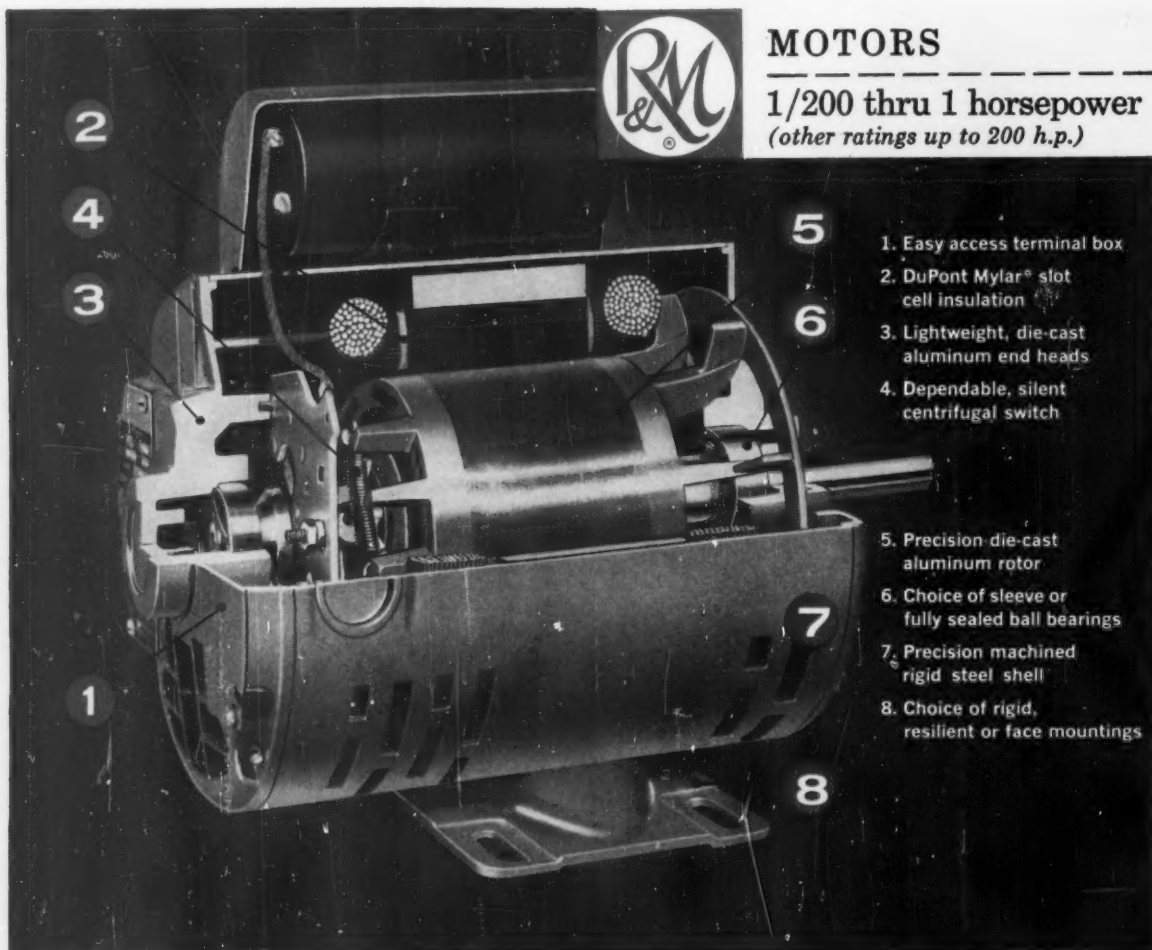
**CONTROL
SWITCH**
DIVISION
CONTROLS COMPANY OF AMERICA

4218 W. Lake Street • Chicago 24, Illinois
Telephone: VAn Buren 6-3100 • TWX No. CG-1400



MOTORS

1/200 thru 1 horsepower
(other ratings up to 200 h.p.)



1. Easy access terminal box
2. DuPont Mylar® slot cell insulation
3. Lightweight, die-cast aluminum end heads
4. Dependable, silent centrifugal switch
5. Precision die-cast aluminum rotor
6. Choice of sleeve or fully sealed ball bearings
7. Precision machined rigid steel shell
8. Choice of rigid, resilient or face mountings

R & M Fractional Horsepower Motors are packed with *Competitive Advantages* for your product!

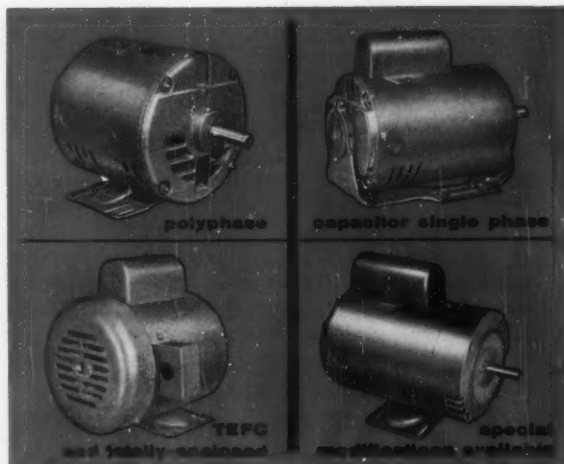
ROBBINS & MYERS "Model R" fractional HP motors, available in NEMA frames 56 and 48, are engineered and manufactured to give your product every possible competitive advantage so far as power is concerned. Each design detail results in superior performance and long trouble-free life, even under the severest operating conditions. They are smaller due to a more efficient ventilating system and lighter because of new applications of aluminum, steel and copper.

You have wider design versatility too, because they are available off-the-shelf in a broad choice of bearings, mountings, ratings, speeds and electrical characteristics.

These up-to-date design features, coupled with careful quality control at each manufacturing step, give you a modern motor you can rely on for all your powering needs. Also, if your needs indicate a custom designed motor Robbins & Myers welcomes the opportunity to discuss your quantity requirements.

Learn all about the many advantages R&M motors offer you by writing today for Bulletin 450 MD

*DuPont registered trademark



ROBBINS & MYERS, INC.

motors, household fans, Propellair industrial fans, hoists, Moyno industrial pumps
SPRINGFIELD, OHIO • BRANTFORD, ONTARIO

Induction Motors

Illustrated Brochure PB 6000-9 covers frame sizes 585 to 589 in the induction series, up to 400 hp in dripproof enclosures and up to 350 hp in enclosed machines. Large photographs illustrate various construction details and modifications. 8 pages. Elliott Co., Crocker-Wheeler Plant, Jeannette, Pa.

Circle 651 on Page 19

Magnetic Tape Transports

Bulletin DS 3170A provides complete specifications, application information, and features of Series 3170 magnetic tape transports. Two, six, ten, and twelve-speed models are covered. Flutter curve is indicated. 4 pages. Minneapolis-Honeywell Regulator Co., Industrial Systems Div., 10721 Hanna St., Beltsville, Md.

Circle 652 on Page 19

Polyurethane Rigid Foam

New brochure describes Vultafoam, a polyether urethane rigid foam of the pour-in-place variety. Folder gives information on properties, applications, and special characteristics. Section on how to use the material is included. 4 pages. General Latex & Chemical Corp., 666 Main St., Cambridge, Mass.

Circle 653 on Page 19

Motor Operators and Valves

Catalog 407 describes a line of electric motor operators and motorized valves. Various types of units are pictured, and features of each are pointed out. Speeds and power data are supplied. Tables provide specifications on the various types of valves. 24 pages. Schade Valve Mfg. Co., 2527-37 N. Bodine St., Philadelphia 33, Pa.

Circle 654 on Page 19

Indexing Components

Catalog 160 is a compilation of standard roller-gear drive indexing mechanisms, high-speed precision index tables, in-line transfer machines, and allied equipment. Complete load ratings, dimensions, and installation data are presented in table form. Many new features are included. 40 pages. Ferguson Machine Corp., 7818 Maplewood Industrial Court, St. Louis 17, Mo.

Circle 655 on Page 19

Locking Coupling

Saf-Loc coupling, Series 3750, for fuel, oil, low-pressure hydraulic, pneumatic, and other systems, is described in Bulletin AEB-40. Principles of operation are shown by diagrams, and tables list all dimensional data. Line drawings show various styles and end fittings available. Pressure loss versus flow information is provided, as well as operating temperatures, materials, and finishes. 4 pages. Aeroquip Corp., Jackson, Mich.

Circle 656 on Page 19

Cast Nonferrous Metals

Colorful brochure, Form FM-3017, presents information on brass, bronze, copper, aluminum, and on standard products avail-

HELPFUL LITERATURE

able. Chemical and physical properties of the various alloys are provided in a four-page chart. Other information includes brass and bronze standard and special shaped rods; brass, bronze, and aluminum forgings and special alloys; ferrous, non-ferrous, and plastic custom-formed parts; and standard products. 20 pages. Mueller Brass Co., Port Huron 8, Mich.

Circle 657 on Page 19

High-Alloy Castings

New booklet, "Technical Publications List," lists 46 technical papers, articles, reprints, and data sheets on stainless and heat-resistant castings. Literature is described, including publication source, under categories of alloy selection, applications, research, engineering data, fabrication, foundry practice, metallurgical structure, properties, testing methods, and such general topics as purchasing of high-alloy castings. 12 pages, 4 x 9 in. Alloy Casting Institute, 1001 Franklin Ave., Garden City, N. Y.

Circle 658 on Page 19

Screws and Splines

Catalog 60-E contains line drawings and cutaways of various screws and splines, and numerous applications are pictured. Standard and custom assemblies are shown, with complete specifications given. Design characteristics are provided, as well as charts and graphs of primary design factors. 24 pages. General Motors Corp., Saginaw Steering Gear Div., Saginaw, Mich.

Circle 659 on Page 19

Footswitches

Deluxe footswitches featuring high electrical ratings are shown and cataloged in new bulletin. Six models are listed. Handy chart shows electrical ratings ranging from 10 amp, 125 v ac to 20 amp, 125-250 v ac. 2 pages. Linemaster Switch Corp., 432 Woodstock Terrace, Woodstock, Conn.

Circle 660 on Page 19

Threaded Inserts

Plug Nuts, hardened, threaded inserts designed to be pressed into ductile material to assure good fastening characteristics, are described in new bulletin. Advantages of the fasteners are listed and pictured, and sections on why and how they are used are provided. Diagrams and text give methods for installation. Dimensions and information on how to select the proper nut are provided in table form. 4 pages. Lamsor & Sessions, 5000 Tiedeman Rd., Cleveland 9, Ohio.

Circle 661 on Page 19

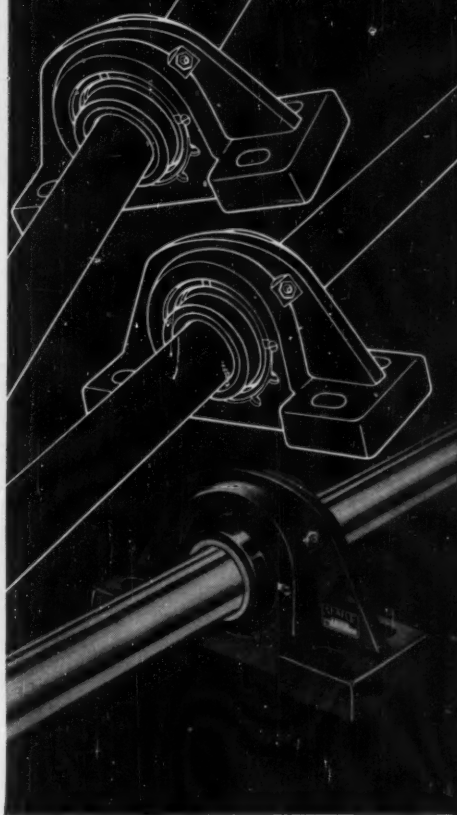
Air Equipment

Bulletin 8-59 provides information on miniature pneumatic valves, cylinders, solenoids, fittings, and accessories. Various bore sizes, mountings, and voltages are included. 4 pages. Clippard Instrument Laboratory Inc., 7350 Colerain Rd., Cincinnati, Ohio.

Circle 662 on Page 19

Another **PLUS** value...

STAMINA AT ANY ANGLE



Under loads or shocks from any angle, whether radial, thrust or combined loads, Shafer Self-Aligning Roller Bearings always retain their high load capacity. Add misalignment and the load still remains safely on the roller centers reducing retainer wear, increasing bearing life. Why? Shafer CONCAVE roller and true sphere race design—proved longer lived in thousands of installations. See your nearby distributor or mail coupon.

SHAFAER[®]

REX[®]

ROLLER BEARINGS

CHAIN Belt Company
4643 W. Greenfield Ave., Milwaukee 1, Wisconsin
(In Canada: CHAIN Belt (Canada) Ltd.,
1181 Sheppard Ave. East, Toronto)

() Please send Shafer Bearing Catalog 59A.

Name.....

Company.....

Address.....

City.....Zone.....State.....

Circle 499 on Page 19

THE BELLOWS AIR MOTOR®



7 MOUNTING STYLES

5 BORE SIZES

BUILT-IN
SPEED CONTROLS

CHOICE OF 6 TYPES OF
BUILT-IN VALVES

THE ONLY AIR CYLINDER WITH A CHOICE OF BUILT-IN VALVES

In designing for air operation, the engineer can choose the method of valving he prefers—and still have all the advantages of integral valve and cylinder construction.

Six different built-in valve arrangements give the engineer every latitude in pneumatic design.

If he prefers to use 8-12 volt electrical control with its simplified wiring, Bellows has it. If he prefers to use 115 volt control and JIC standards, Bellows has it. If he requires low or high voltage explosion-proof control, Bellows has it. Should his design require full pneumatic control, Bellows has it. Or should he

wish to control his pneumatic circuits manually or through mechanical linkage or cams, Bellows has it.

Unlike conventional air cylinders which require separate remote directional and speed control valves and dual piping, the Bellows Air Motor is a complete power unit with directional valve and dual speed control valves built-in as an integral part of the unit. Only one air connection, which can be made with flexible hose, is required.

Integral valve and cylinder construction means quick response, more positive response, more precise control and more economical operation.

The Bellows Air Motor is made in five bore sizes: 1¼", 1¾", 2½", 3⅝", and 4½", and in any stroke length.

WRITE FOR THIS BULLETIN TODAY!



627C-3

Four-color, 20-page bulletin describes the complete line of Bellows Air Motors. Free on request. Address Dept. MD-660, Bellows-Valvair, Akron 9, Ohio.

Bellows-Valvair

The Bellows Co. • Valvair Corp. Akron 9, Ohio

DIVISIONS OF INTERNATIONAL BASIC ECONOMY CORPORATION (IBEC)

Specialty Metals

New technical bulletin, "Handbook of the Alloyist," pinpoints the advantages of several groups of alloys used in the electrical and electronics industries. Pamphlet includes a discussion of the properties of each alloy suitable for use in the industry, with typical applications also provided for each alloy. Alloys include phosphor bronze, nickel alloys, nickel silvers, stainless steel, and nickel-clad copper wire. 8 pages. H. K. Porter Co. Inc., Riverside-Alloy Metal Div., Riverside, N. J.

Circle 663 on Page 19

Screws and Bolts

Colorful new brochure contains dimensional data, photographs, and drawings on Stanscrew hex and hex screws, carriage bolts, and lag screws. Booklet also contains brief descriptions of other units available. 6 pages. Standard Screw Co., 2701 Washington Blvd., Bellwood, Ill.

Circle 664 on Page 19

RTV Silicone Rubber

Designated CDS-226, illustrated publication highlights the properties of RTV silicone rubber and illustrates its uses in electronic and electrical assemblies, as a sealing, coating, impregnating, and bonding compound in a variety of applications, and its performance as a flexible mold material. Special section is devoted to a review of RTV applications as a sealant in aircraft and missiles. 12 pages. General Electric Co., Silicone Products Dept., Waterford, N. Y.

Circle 665 on Page 19

Stock Springs

Over 750 springs, available for immediate delivery from stock, are listed in Catalog 101. Catalog contains complete engineering data and prices for all sizes. Springs include compression, extension, and instrument types manufactured to engineering standards, made of music wire and stainless-steel, and meeting military specifications. 20 pages. Lee Electronics Inc., Lee Spring Co. Div., 30 Main St., Brooklyn, N. Y.

Circle 666 on Page 19

Refractory Metal Chart

New chart shows the complete properties of tungsten, tantalum, molybdenum, and columbium. Reverse side contains a temperature chart for conversion of degrees F to degrees C or vice versa. It is scaled from absolute zero to 3600 C (6512 F) and includes formulas for exact conversions arithmetically. 2 pages. Fansteel Metallurgical Corp., Metals & Fabrication Div., Dept. MD-1, North Chicago, Ill.

Circle 667 on Page 19

Belt Drives

Catalog Section 125 is an engineering and specification guide for recently introduced Hi-Cap Wedge belt drives. Publication includes: Step-by-step instructions for drive selection, with tables of service factors, horsepower, and other data; dimensions and weights of 182 stock and 54 custom Hi-Cap Wedge QD sheave sizes;

HELPFUL LITERATURE

specifications of QD bushings, bores, and keyways; drive installation and removal instructions. 28 pages. Fort Worth Steel & Machinery Co., 3600 McCart St., Fort Worth 10, Tex.

Circle 668 on Page 19

Air Cylinders

New Catalog 88 illustrates complete lines of air cylinders, valves, clamps, and dial feed tables. Line drawings are provided, along with photographs of the various units, full specifications, and price lists. 88 pages. Allenair Corp., 255 E. Second St., Mineola, N. Y.

Circle 669 on Page 19

Tubeaxial Fans

Bulletin 625 describes 30 to 60-in. Type BT and BTV belt-driven tubeaxial fans. Air deliveries range up to 85,000 cfm. Literature gives application details for polluted and high-temperature atmospheres they handle. Bulletin also includes data on ventilating-system designs with emphasis on hood design and open-surface tank ventilation. Photographs, tables, and engineering drawings are used throughout. 8 pages. Robbins & Myers Inc., Propellair Div., Springfield, Ohio.

Circle 670 on Page 19

Aluminum Bearings and Bushings

"Alcoa Bearings," a new study, is an extensive collection of case histories, engineering and test data pertaining to sleeve bearings and bushings of aluminum. Art and science of designing bushings is discussed fully in the booklet. Ten case histories, detailing common and exceptional applications, preface two large sections of engineering and test data. Liberal use is made of charts, graphs, drawings, and photographs in the technical discussion. 90 pages. Aluminum Co. of America, Room 732, Alcoa Bldg., Pittsburgh 19, Pa.

Circle 671 on Page 19

Uses of Tin

Colorful new booklet, written in non-technical terms, presents the story of tin in the major categories of its consumption. Chapters are devoted to the uses of tin for tinplate, solder, bronze, white metal, babbitt, tinning, collapsible tubes and foil, chemicals, and miscellaneous alloys. 20 pages. Malayan Tin Bureau, Dept. TN, 2000 K St. N.W., Washington 6, D. C.

Circle 672 on Page 19

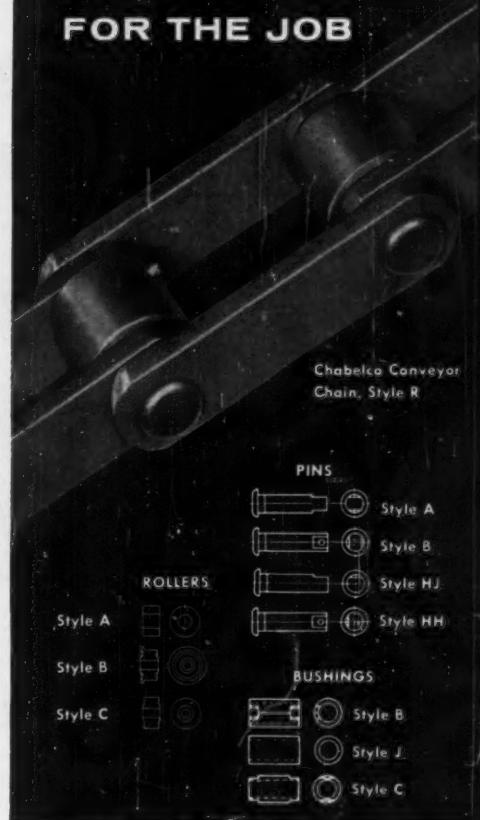
Fast-Pulse Camera

Fast 16mm Pulse Camera, Model 370, is described in new printed data. Camera can be pulsed to 30 fps and carries 100 ft of roll film. Literature describes an important application in slow-motion movies of destructive resonances in vibration tests. Camera is directly useful for conventional pulse-camera data recording, and for time-lapse work. 2 pages. Chadwick-Helmuth Co., 472 E. Duarte Rd., Monrovia, Calif.

Circle 673 on Page 19

Another **PLUS** value...

COMPONENTS "TAILOR-MATED" FOR THE JOB

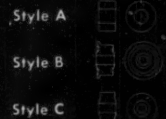


Chabelco Conveyor Chain, Style R

PINS



ROLLERS



BUSHINGS



Need a "special" conveyor chain for a tough service condition such as shock loads or abrasion? In the Rex Chabelco line you'll find just the chain you need—a stock chain with "tailored" strength and wear-resistance for your specific service requirements.

The Chabelco line features a variety of pins, bushings and rollers—each designed for specific service. The right combination assures maximum service life—eliminates risky under-chaining, costly over-chaining.

REX®

CHABELCO® ELEVATOR
AND CONVEYOR CHAINS

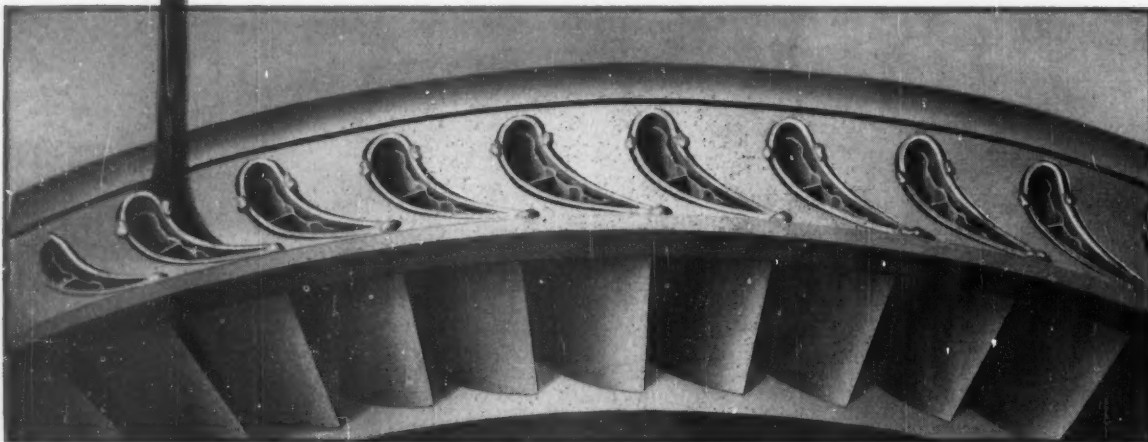
CHAIN Belt Company 60-103
4643 W. Greenfield Ave., Milwaukee 1, Wis.
(In Canada: CHAIN Belt (Canada) Ltd.,
1181 Sheppard Ave. East, Toronto, Ont.)
☐ Send information on Chabelco Elevator
and Conveyor Chains. ☐ Have a Rex man
call.

Name.....
Company.....
Address.....
City..... Zone..... State.....

Circle 501 on Page 19

Metallurgical Memo from General Electric

G-E Vacuum-Melted Alloys Now Conquer Wide-Gap Brazing Barriers



Wide-gap brazing alloy is applied to turbine nozzle assembly. Vanes are tack-welded in position prior to brazing.

New G-E Wide-Gap Brazing Alloys offer:

- New brazing techniques
- Bridging of joint clearance up to .060 in.
- Faster, more simplified job fabrication
- Extreme cleanliness provided by induction vacuum melting
- Improved erosion characteristics
- Solution to many problems of distortion and stress relieving associated with fabrication by welding
- Lower manufacturing cost

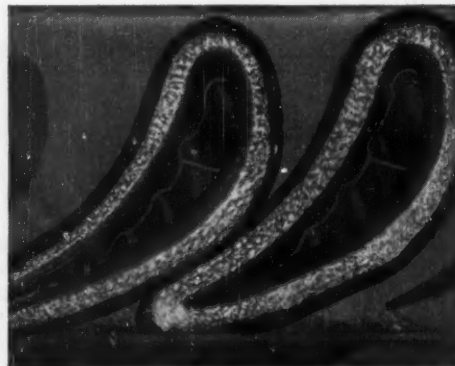
Looking for new methods of fabricating high-temperature metals? Nothing can equal G-E vacuum-melted brazing alloy powders for critical applications. All provide the ultimate in exacting chemical control and extreme cleanliness which air-melted alloys cannot match.

Now this latest G-E brazing "breakthrough" of wide-gap alloys extends the use of brazing to a new, wider scope of joining applications.

Get all the facts about G-E vacuum-melted brazing alloys as a short-cut to lower cost manufacturing methods. Write: Metallurgical Products Department of General Electric Company, 11159 E. 8 Mile Avenue, Detroit 32, Michigan.

METALLURGICAL PRODUCTS DEPARTMENT

GENERAL  ELECTRIC



Insert shows vanes completely brazed in spite of gaps. Stains around perimeter of brazes are from stopoffs.

CARBOLOY® CEMENTED CARBIDES • MAN-MADE DIAMONDS • MAGNETIC MATERIALS • THERMISTORS • THYRISTORS • VACUUM-MELTED ALLOYS

Impulse Counters

Sodeco Ti Series heavy-duty electric impulse counters are described in new bulletin. Complete technical data includes operating instructions, execution possibilities including several circuit diagrams, electrical information for both ac and dc models, and dimensional data. Bulletin illustrates and describes several types of counters, all available with manual or electric reset. 6 pages. Landis & Gyr Inc., 45 W. 45th St., New York 36, N. Y.

Circle 674 on Page 19

Precision Gears

Catalog F-128 contains information on gears, breadboard items, clamps and collars, couplings, differentials, gearheads, shafting, clutches, and speed reducers, all available from stock. Data are also provided on materials, finishes, tolerances, and sizes. 128 pages. Dynamic Gear Co. Inc., Amityville, N. Y.

Circle 675 on Page 19

Slide Assemblies

All data necessary for designing standard slide assemblies into special or semi-special production equipment for straight-line precision movements are provided in Catalog 1000. Both photographs and drawings are included. Complete dimensional and operating information is furnished on nine major types of slide assemblies, available in 123 standard models and sizes. Full-size end-section tracing templates and pictorial index are included. 24 pages. Russell T. Gilman Inc., 623 Beech St., Grafton, Wis.

Circle 676 on Page 19

Seals and Fasteners

Catalog 359A describes single-unit, high-pressure Hexseals, Seelbolts, Seelscrews, Seelrivits, and Rubrglas-Seels. List of applications is included for the various units. Line drawings are provided for each type of fastener and seal, and tables present pertinent engineering data. 16 pages. APM Corp., 252 Hawthorne Ave., Yonkers, N. Y.

Circle 677 on Page 19

Thin Bearings

Real-Slim bearings are described in Engineering Catalog 54. General information is provided on capacity and design data, and on flame hardening. All types of the bearings are shown, along with specifications and new price schedule. Line drawings are provided for all types of bearings. 26 pages. Kaydon Engineering Corp., Muskegon, Mich.

Circle 678 on Page 19

Screw Thread Root

Actual "Achilles' heel" of properly made tension bolts and screws is the shape at the bottom or root of the screw thread. New pamphlet, "The Root of the Thread," provides designers and fastener users with a thorough review of the problem. Items included are: Listing of the basic criteria for a good thread root; comparative analysis of three widely used thread forms, including data on relative performance in tension-fatigue and at tem-

HELPFUL LITERATURE

perature; complete specification for a large, round root radius that has been introduced; capsule history of the evolution of this design aspect of the thread; and a preview of new large-radius-root screw-thread standards expected. 20 pages. Standard Pressed Steel Co., Jenkintown, Pa.

Circle 679 on Page 19

Pressure Regulators

Catalog J160-1 provides information on complete line of sliding-gate pressure regulators. It describes in detail the self-operated, pilot-operated, solenoid-operated, and back-pressure regulators. Catalog describes the applications of each of the four basic types of regulators and tells how each type operates. It also incorporates cutaway drawings, sizing charts, flow curve, sample specifications, and complete engineering information. OPW-Jordan, 6013 Wiehe Rd., Cincinnati 13, Ohio.

Circle 680 on Page 19

Couplings

Bulletin 56 contains data on gear couplings, flexible couplings, high-misalignment types, and cut-out units. Each type is pictured and line drawing is provided. Tables present complete engineering data. 4 pages. Midland-Ross Corp., Waldron-Hartig Div., New Brunswick, N. J.

Circle 681 on Page 19

Measuring Instruments

Bulletin RM-5-60 provides information on components and complete systems for measuring force and distance. Units are pictured, and pertinent data are provided for each. Prices are also included. 12 pages. American Machine & Metals Inc., Riehle Testing Machines Div., East Moline, Ill.

Circle 682 on Page 19

Electric Clutches and Brakes

Entire product range of electric clutches and brakes is fully illustrated and described in colorful new brochure. Both technical data and diagrammatic sketches of more than 20 types of fixed-field, miniature, small, and larger electric clutches and brakes are included. Data on sizes, rated static torque and coil power watts are included. Conversion table and clutch-brake selection data section are also provided. 6 pages. Simplatrol Products Corp., 24 Salisbury St., Worcester, Mass.

Circle 683 on Page 19

Self-Bonding Nameplates

Bulletin 161-A, "New Dimensions in Nameplate Design," explains a new type of nameplate, Poly-Plate, that identifies the product and also serves decorative, functional, and protective purposes. Nameplates combine subsurface printing and metalizing with protective qualities of Mylar. 4 pages. W. H. Brady Co., Dept. 161, 727 W. Glendale Ave., Milwaukee 9, Wis.

Circle 684 on Page 19

Another **PLUS** value...

CUSHIONS

IMPACT LOADS



The roller in a roller chain must provide maximum resistance to its impact against sprocket teeth for longest wear life. A **PLUS VALUE** of Rex Roller Chains is really round rollers. This provides full bearing against the bushing for maximum life. For complete story, mail the coupon.

REX®

ROLLER CHAINS

CHAIN Belt Company 403
4643 W. Greenfield Ave., Milwaukee 1, Wis.
(In Canada: CHAIN Belt (Canada) Ltd.,
1181 Sheppard Ave. East, Toronto, Ontario.)

☐ Send my copy of Bulletin 5725.
☐ Have a Rex Man call.

Name.....

Company.....

Address.....

City.....Zone.....State.....

Circle 503 on Page 19

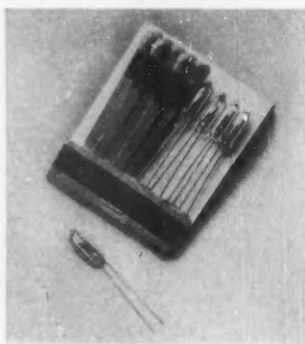
New Parts and Materials

Use Yellow Card, page 19, to obtain more information

Miniature Switch

mercury unit is
1/2 in. long

Developed initially as a reversing switch for a portable electric device suited for such applications as miniature on-off switch, paging devices, hearing-aid switch, switching requiring slight force, or applications that have a low load, light weight, or space factor. Specifications are 1/2 in. maximum length, 0.162 in. diam,



and 1/10 amp rating. Switching action is SPST and differential angle is 15 deg. AC load at 115 and 230 v is 0.1 amp; dc load at 115 and 230 v is 0.1 amp. Lamp load is 10 w. Standard lead wire is 8-in. length of No. 26 PVC. Gordos Corp., 250 Glenwood Ave., Bloomfield, N. J.

Circle 685 on Page 19

Steel Clips

can be opened to full length
and returned to original shape

New steel clips have the capacity to be opened repeatedly and closed without taking a permanent set. Neg'ator clips can be opened to their full length and, when released, will return to their original shape. Clips are strips of spring material which have been highly prestressed to a given curvature. When ex-



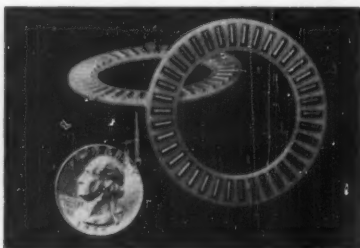
panded slightly from this natural diameter they exert an exceptionally strong embracing force. Clip shown has a natural ID of 1 7/8 in., is 0.25 in. thick and 1 in. wide. Materials include 301 high-yield stainless steel, high-strength stainless, high-carbon steel, and other alloys. Hunter Spring Company Div., American Machine & Metals Inc., 1 Spring Ave., Lansdale, Pa.

Circle 686 on Page 19

Needle Thrust Bearing

employs nylon retainer
to reduce sliding friction

Type NJ needle thrust bearing uses a glass-fiber-filled nylon retainer to reduce undesirable sliding friction inherent in all-steel needle thrust bearings. Use of nylon also provides greater life with negligible retainer wear. Injection-molded retainer has exceptionally high strength and stability. Thrust capacity of the new bearing is equal to or greater than the capacity of all-steel bearings, and permissible operating speeds are greater. Bearing operates at a lower temperature than all-steel unit by



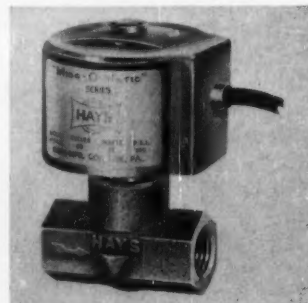
having lower heat conductivity and less heat generation. Needle roller diameters have been standardized at 0.078 in. for the entire line of bearings. Bearing can be produced in infinite combinations of bore and OD sizes. Kaydon Engineering Corp., Muskegon, Mich.

Circle 687 on Page 19

Solenoid Valve

controls small flows
of water or air

Designed for applications where space is definitely limited, Midg-O-Matic solenoid valve provides for the accurate automatic control of small flows of water or air. Available in a wide range of voltages and solenoid types, valve is furnished in angle or straight pattern. Unit is available for a wide range of working pressures to 150 psi. Valve is available with moistureproof or waterproof solenoid coils. Waterproof



coil, known as Kast-Coil, is guaranteed forever. Automatic Controls Div., Hays Mfg. Co., 805 W. 12th St., Erie, Pa.

Circle 688 on Page 19

High-Torque Motor

has split-second
starting and stopping

Rotorac high-torque, lightweight, low-speed motor, operating from a

Tests point way to efficient high-speed drives

the BIG
PLUS value

In many chain drive applications, machine designers are seeking more efficient ways to handle higher speeds and greater horsepower. Foreseeing this trend, CHAIN Belt engineers began an intensive program of research into the effects of greater speeds and horsepower on chain life.

Thousands of hours' testing gave definite evidence that new concepts of chain selection were needed in the higher speed ranges. *Shorter* pitch chains were proved to have more horsepower capacity than longer pitch chains at higher speeds. As the chart above shows, the horsepower capacity of a given pitch chain increases to a peak at a definite point in the r.p.m. of the sprocket. Beyond this point, the h.p. capacity of the bushing and roller decreases. But this point is higher for the shorter pitch chain than for the longer. The heavier link plates in the longer pitch chain (Drive No. 1) enable it to handle a greater load at 500 r.p.m. than the shorter pitch chain. At 1500 r.p.m., however, the shorter pitch chain handles a much heavier load.

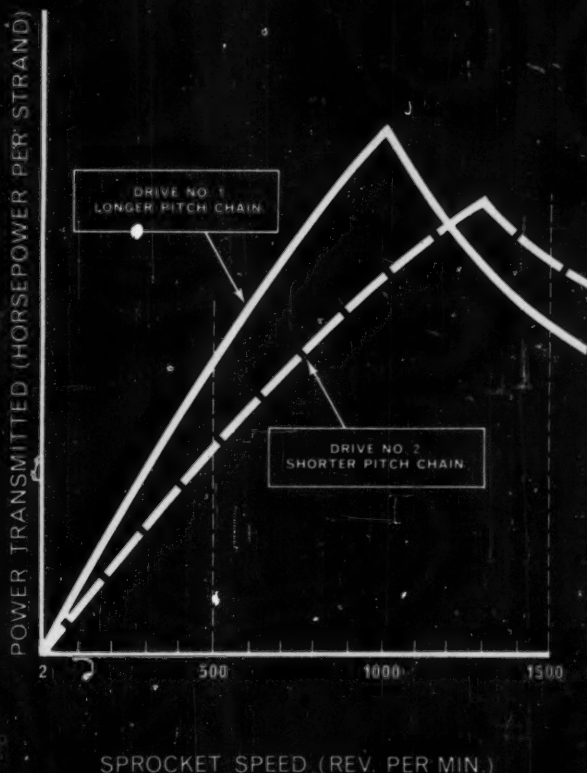
In any given application, there is an optimum pitch and sprocket size that should be used. CHAIN Belt engineers, through their exhaustive testing program, have made determinations that assure the right choice of chain for each type of service. If you have a problem involving higher speed power transmission, we suggest you have your CHAIN Belt man review your requirements. Write CHAIN Belt Company, 4643 W. Greenfield Ave., Milwaukee 1, Wis.

REX®

CHAIN BELT COMPANY

Circle 504 on Page 19

HORSEPOWER CHART FOR ASA ROLLER CHAIN





REEVES Vari-Speed Motodrive

packed with new flexibility . . . broader production use

Now available in this compact design, Reeves Vari-Speed Motodrives deliver 2:1 through 10:1 speed variation, 1.8 through 4660 r.p.m. . . $\frac{1}{4}$ to 20 hp.

The infinitely variable output speeds meet almost every production need.

You can get these drives with output shaft

on same or opposite side of the motor; vertical, 45°, horizontal or trunnion models; no reducer, and single, double or triple stage reductions . . . hundreds of space saving assemblies. Reeves provides a full range of modifications, accessories, and manual, remote or automatic controls.

G-1659

Product of the combined
resources of
Reliance Electric and
Engineering Company and its
Master and Reeves Divisions

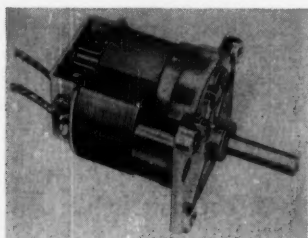


**RELiance ELECTRIC AND
ENGINEERING CO.**

DEPT. 286A1, CLEVELAND 17, OHIO
Canadian Division: Toronto, Ontario
Sales Offices and Distributors in Principal Cities



Duty Master A-c. Motors, Master Gearmotors, Reeves Drives, V+S Drives, Super 'T' D-c. Motors, Generators, Controls and Engineered Drive Systems.



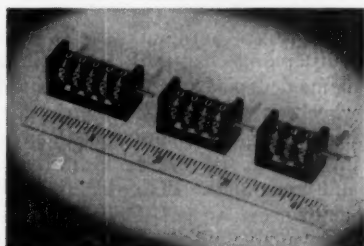
60-cycle power source, delivers 6 lb.-in. of torque at 20 rpm for a 0.75-amp, 115-v input. Torque is delivered for any angular rotation of the output shaft. Unit has split-second starting and stopping characteristics. Other features include ability to sustain stall conditions without damage to motor or mechanism, and ability to accommodate reasonable adjustments to speed-torque characteristic. Motor is available in a variety of types, and can be supplied for operation at most standard voltage levels. Airborne Accessories Corp., 1414 Chestnut Ave., Hillside 5, N. J.

Circle 689 on Page 19

Subminiature Counters

1/2-in. wheel units have
2000-rpm speed

Series S subminiature instrument counters, 1/2-in. wheel units, are designed for use in missile-tracking devices, radar equipment, navigation instruments, computers, and similar instruments where high speeds and accurate counts must be obtained with a minimum of weight and space. Standard models are available in three, four, and five-figure instruments, with additional figures or special combinations available on order. Units are rated at a speed of 2000 rpm, and tabulate ten counts with each revolution in standard models. Counters, housed in a die-cast, one-piece frame, withstand temperatures from -60 to +85 C. Number wheels are one-piece precision molded, and standard figures



June 23, 1960

useful information on castings

DESIGN • PURCHASING • MACHINING

If you want more information about iron castings it's yours for the asking. Just check as many of these bulletins as you would like, clip this ad and mail it to us.

- ☐ Casting Design as Influenced by Foundry Practice
- ☐ Summary of Specifications for Gray and Nodular Cast Irons
- ☐ Hamilton Quality Ductile Iron
- ☐ Engineering and Purchasing Requirements for Gray Iron Castings
- ☐ Engineered Castings from Hamilton Foundry
- ☐ Handbook of Meehanite Metals
- ☐ Machining and Abrasive Finishing Gray and Nodular Iron
- ☐ Glossary of Terms—For Producers, Users of Iron Castings

Iron Castings have tremendous design flexibility—but there are certain danger points to be avoided. In addition, there is an engineered iron best suited to your combination of design and use requirements. You can get competent advice at any time from Hamilton Foundry engineers on these questions—and any other castings problem on your boards.

Name _____ Title _____

Company _____

Address _____

City _____ Zone _____ State _____

GRAY IRON • ALLOYED IRON • MEEHANITE® • DUCTILE (NODULAR) IRON • NI-RESIST • DUCTILE NI-RESIST • NI-HARD

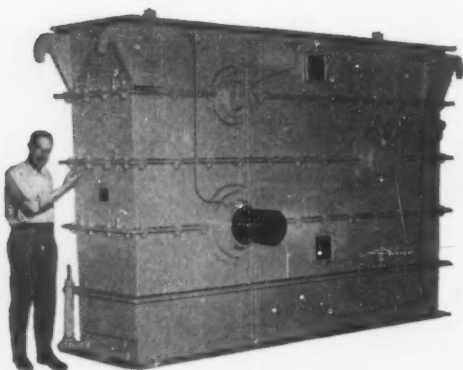


HAMILTON FOUNDRY INC.

1551 LINCOLN AVENUE • HAMILTON, OHIO • TWInbrook 5-7491

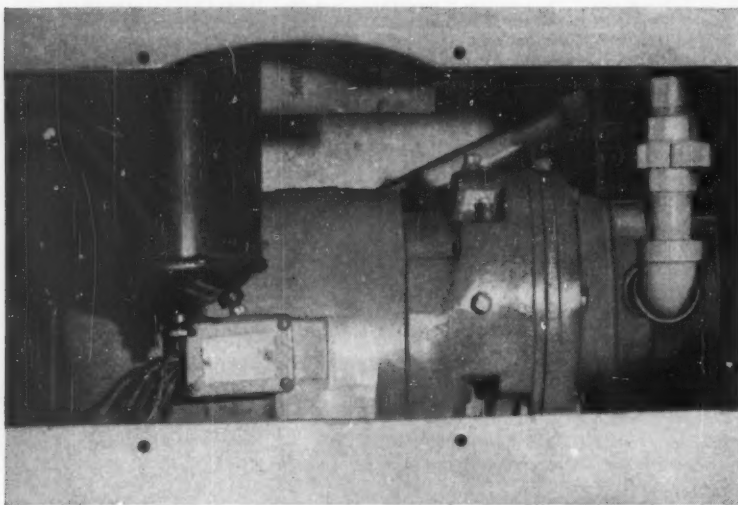
Circle 505 on Page 19

193



Morse Chain Co. is engineering four of these chain transmissions for an irrigation and flood-control project. Each handles a 758 hp input from a diesel engine — reduces 707 rpm speed to 66.6 rpm for a water impeller pump.

Why Morse Chain designers lubricate huge transmissions with Brown & Sharpe pumps



Brown & Sharpe Model 113 Motor Driven Gear Pump, used in each transmission.

Problem: A dependable motor driven gear pump was needed to spray lube oil on 7"- and 12"- wide Hy-Vo® chains and sprockets in this big transmission unit. Shaft bearings were to be lubricated by the system, too. A capacity of 18 gpm, at 0 psi was called for — continuous operating pressures of 10 psi, with a specified oil. For ease of maintenance, a standard unit was preferred.

Solution: Since the designers had previously obtained excellent results with Brown & Sharpe pumps, they

took a look in the B&S catalog — found exactly what they needed. B&S 100 series pump and motor combinations for 900 rpm operation were shipped promptly, are being built into all of the transmissions.

Idea: For the best solution to any pump problem — contact Hydraulics Division, Brown & Sharpe Mfg. Co., Providence 1, R. I. or your B&S engineer-representative. Brown & Sharpe makes gear, vane and centrifugal pumps to handle more fluids than any other manufacturer.

Brown & Sharpe
PRECISION CENTER

NEW PARTS AND MATERIALS

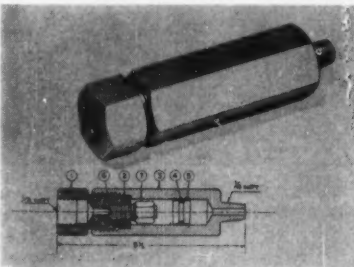
are 1/8-in. high, printed white on a black background. Units are available with either right or left-hand drive. Durant Mfg. Co., 1933 N. Buffum St., Milwaukee 1, Wis.

Circle 690 on Page 19

Flow-Check Snubber

is responsive to
small pressure changes

Full protection of plant personnel and instruments against the escape of noxious, toxic, or flammable liquids or gases in the event of pressure instrument failure is one of the features of a new flow-check snub-



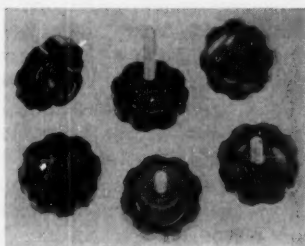
ber. Unit completely isolates instruments from pressure-actuating medium and assures accurate readings from 100 to 5000 psi. Design modifications of the original snubber (to 30,000 psi and more) make the device extremely responsive to small pressure changes within its range, with full equilibrium reached in 2 to 3 sec. Designed to work equally well with instruments actuated by bourdon tubes or diaphragms, the simple, self-contained device houses a snubber which prevents transmission of transient line surges or pulsations. It will not clog or plug because snubber is assembled into sealed system of device. Chemiquip Co., 36 East 10th St., New York 3, N. Y.

Circle 691 on Page 19

Knobs and Handwheels

have large,
fluted grip

Outstanding characteristic of a line of molded plastic knobs and handwheels is a large, fluted grip for heavy-duty and high-torque clamping devices, adjusting rods, valves, and regulators. Both knobs and handwheels are 2 3/8 in. OD and are available with plain cored holes,



tapped brass inserts, and protruding studs. Knobs, with $\frac{1}{2}$ in. longer hub than handwheels, can also be obtained with reamed brass bushings and setscrews for $\frac{1}{4}$ and $\frac{1}{2}$ -in. shafts. Black phenolic is the standard material; parts can also be furnished in many phenolic and urea colors and with such special characteristics as chemical and high-heat resistance, extra strength, and low friction. Dimco-Gray Co., 207 E. Sixth St., Dayton 2, Ohio.

Circle 692 on Page 19

Contact-Bond Cement

forms high-strength
bonds immediately

Fast-drying contact-bond cement, Rez-N-Glue 266, is well suited for bonding plywood to linoleum or hard sheet plastic, clad aluminum to plywood, and hard sheet plastic to aluminum. Adhesive forms high-strength bonds immediately after assembly of sections. Bond resists water, oils, gasoline, heat, and cold, and remains flexible at temperatures to -40 . Immediate high strength of bond increases with aging. The cream-color, oil-resistant, synthetic-rubber-base adhesive requires no thinning. It is supplied in 1-qt, 1, 5, and 55-gal containers. Schwartz Chemical Co. Inc., 50-01 Second St., Long Island City 1, N. Y.

Circle 693 on Page 19

Packaged Bearings

combine advantages of
sleeve and ball bearings

Hy-Film bearings are packaged, off-the-shelf units interchangeable with ball bearings in bore and shaft requirements. Unique features include a base life of 20,000 hr, lifetime recirculatory oiling system, and a hydrodynamic oil film between inner race and bushing which supports weight of shaft. There is



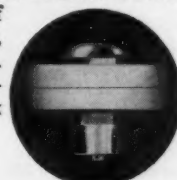
Townsend Lockbolts now available in Stainless Steel for greater strength ...corrosion resistance

If you need extra strength in fastening your assembly—plus corrosion resistance—you can get both now with Townsend 18-8 stainless steel lockbolts.

The use of Townsend stainless lockbolts gives you greater flexibility of design and the values are highly uniform. There is no chance for human error in setting lockbolts. Men with no special training get strong, vibration-proof joints every time.

Townsend stainless lockbolts are vastly easier to install—for example, they eliminate the back breaking work of bucking stainless rivets which work-harden rapidly.

Townsend lockbolts are also available in carbon steel and aluminum alloy in a wide range of diameters and grip lengths in brazier, button and 90° countersunk head styles. Write today for information to Engineered Fasteners Division, P.O. Box 71-E, Ellwood City, Pennsylvania.



Licensed under Huck patents RE 22,792; 2,114,493; 2,527,307; 2,531,048; 2,531,049 and 2,754,703

Townsend Company

ESTABLISHED 1914

Engineered Fasteners Division

ELLWOOD CITY • PENNSYLVANIA

Country Branch Divisions • South American Divisions

PRECISION BALL BEARINGS

NEW HDR SERIES

More Bearing in Less Space

Fractured Ring Technique Provides Breakthrough to High Performance

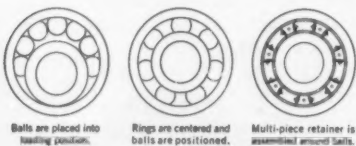
Understandably, selecting a precision ball bearing in which the outer ring has been intentionally fractured is difficult for many engineers long used to thinking in conventional terms of bearing quality. Just as the nameless pioneer who ate the first oyster discovered, despite his probable qualms, that it was extremely palatable and healthful, we hope you'll read on and discover the many advantages of HDR ball bearings.

HDR ball bearings combine the capacity of maximum ball complement bearings with the overall performance characteristics of Conrad-type ball bearings, plus the advantage of a one-piece outer land-riding retainer. This new high performance bearing is made possible by Split Ballbearing's patented fractured ring construction method.

The development of the HDR bearing by Split Ballbearing engineers grew out of the demand for a high performance deep-groove ball bearing, dimensionally interchangeable with standard metric sizes, but with considerably greater capacity and life. General proportions between ball size, ring thickness and raceway shoulders were already well established. The problem was to introduce a greater number of the same size balls between the inner and outer rings without resorting to performance-limiting construction features such as loading slots or counterbored rings.

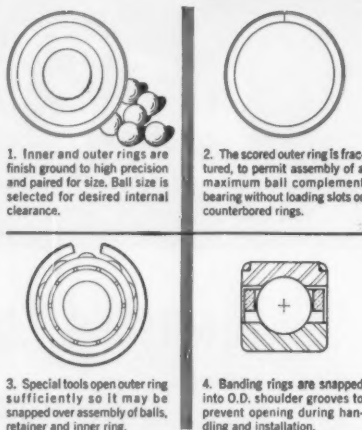
The construction and assembly of the HDR bearing is the unique solution to the problem. Many hundreds of successful applications of HDR type bearings testify to the sound practicality of their design.

The deep, uninterrupted and symmetrical raceways in both rings of HDR bearings permit relatively high thrust loads in either direction and are ideal for high speed operation. Conrad-type bearings have similar raceway construction, but considerably less load capacity due to their smaller complement of balls.



Conrad type construction — note how ball complement is limited to about half of available space due to eccentric displacement of rings.

HDR bearings have up to 56% greater load capacity than equivalent size Conrad types. Since bearing life varies inversely as the cube of the applied load, HDR bearings will yield up to 280% greater life, at a given load, than Conrad-type bearings of the same size. How do Split engineers build these high performance bearings? It's relatively simple — look at these diagrams:



Using maximum ball complements, HDR bearings offer greater rigidity, with an average of 26% less deflection than Conrad-type bearings. Because of their higher radial static capacity, they have an average resistance to shock loads 43% greater than Conrad-type bearings.

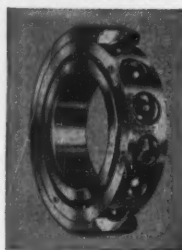
A further important advantage of the HDR construction and assembly method is the use of a simple one-piece ball retainer of maximum strength. The retainer is made of bronze, for low friction, and is piloted on the ground shoulders of the outer ring. This piloted, or land-riding construction, keeps the retainer concentric with the bearing rings under all conditions of operation. Because there is more room for retainer material outside the ball circle diameter than inside, the outer land-riding design provides maximum strength. Since the balls do not have to support the weight of the retainer, friction is minimized at the points of high velocity sliding in the ball pockets, thus permitting higher operating speeds.

HDR ball bearings are made in four standard AFBMA series of bearing envelope proportions: Series 000 extremely light Series 200 light Series 100 extra light Series 300 medium. The present size range is from 10 mm bore through 85 mm O.D. They are available in two grades of precision — ABEC-3 and ABEC-5.

The handling and mounting of HDR bearings is exactly the same as for conventional precision ball bearings.

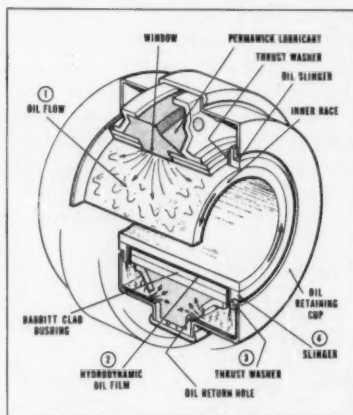
NEW CATALOG on HDR series

Complete information on Split Ballbearing's new HDR precision ball bearing. Write today for Catalog 60.



NEW PARTS AND MATERIALS

no metal-to-metal contact at any point. Bearings are virtually vibration and noise-free, are resistant to humid and gritty atmospheres, and do not leak oil. Recommended operating temperatures range from -25 to +200 F. Bores from 8 to 40 mm will be stocked. Bearings are especially valuable in applications where noise, vibration, and conducted resonance are a problem. Oil is released to the shaft from self-wicking lubricant through a bearing window. Oil slingers on the inner race and an oil return



passage at each end of the bearing complete the recirculatory system. Tann Bearing Co., Div., Tann Corp., 3750 E. Outer Drive, Detroit 34, Mich.

Circle 694 on Page 19

Expanded Teflon Tubing

will recover original dimensions promptly

Thin and standard-wall Teflon-TFE tubing which has been expanded mechanically will recover original dimensions promptly. It clamps tightly to inserted object to form a tighter fit when heat is applied, and retains outstanding electrical, mechanical, and chemical properties of Teflon. Tubing, which can be obtained in 11 basic colors, printed and cut to required lengths, has many uses, including: Encasing irregular shapes; protecting electrical components such as wire connectors, terminals, and semiconductors; joining chemical tubes and metal fittings; providing tight fits over rollers and machined parts. Tubing can be made cementable, and of-



split ballbearing
A DIVISION OF MPB, INC.

310 HIGHWAY FOUR, LEBANON, NEW HAMPSHIRE

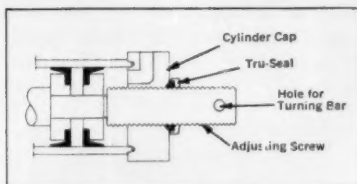
fers the advantages of good dielectric strength, lowest dielectric constant and dissipation factor of any solid dielectric, no change of electric properties with temperature or frequency, and zero moisture absorption. It is unaffected by any commercial chemical. **Pennsylvania Fluorocarbon Co. Inc.**, 1115 N. 38th St., Philadelphia 4, Pa.

Circle 695 on Page 19

Power Cylinders

have adjusting screw
in end cap

Threaded adjusting screw, quickly sealed and unsealed, with a threaded fitting is offered for rapid, easy adjustment of cylinder strokes. Adjusting screw is installed in cap end of power cylinder. When turned clockwise it enters cylinder bore where it acts as a solid stop to limit stroke to exact length desired. Teflon-sealed Tru-Seal straight-thread fitting seals adjusting screw against air or oil leakage from cylinder and keeps screw securely locked in position. Cap-end stroke adjustment is available in all bore sizes of Miller air and hy-



draulic cylinders. **Miller Fluid Power Div., Flick-Reedy Corp.**, York and Thorndale Roads, Bensenville, Ill.

Circle 696 on Page 19

Subminiature Actuators

ballistic-type units are
for push or pull action

Small, rugged, and with high specific-energy output, new actuators are suitable for subminiature applications. The ballistic units can replace solenoids in many aircraft and missile applications where they reduce weight, space, and electrical power needs. Models are available for either push or pull action, in a range of predetermined strokes, and force outputs to 25 lb. Various electrical firing characteristics can be

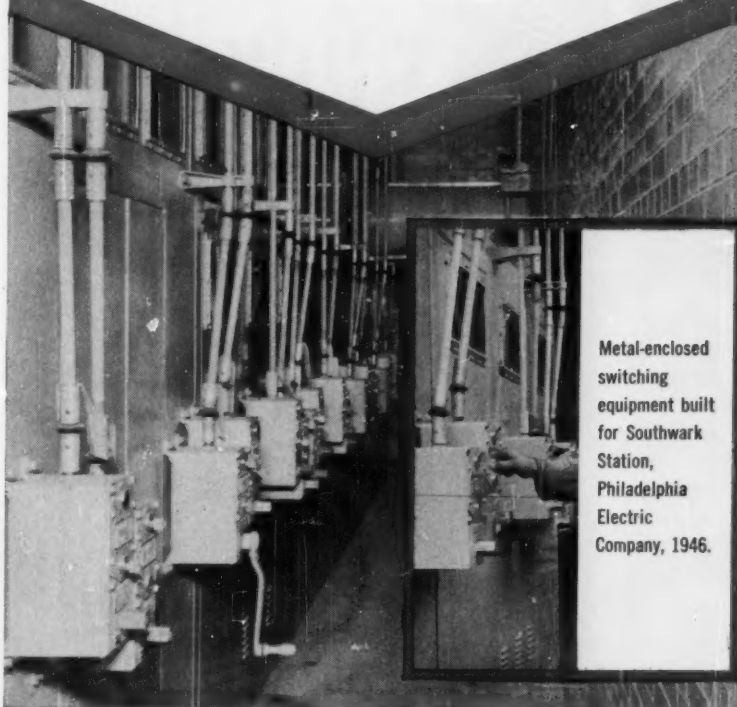
APEX UNIVERSAL JOINTS GIVE YOU COMPLETE DESIGN FLEXIBILITY

I-T-E Circuit Breaker Company selected Apex universal joints because "they offer full flexibility in designing various types of off-center switch operating mechanisms".

Used for indoor and outdoor service under varying temperatures and humidity conditions, Apex covered universal joints "solved all our problems for a very compact, easily installed operating shaft".

Working out a dependable, efficient drive-line design is so much easier when you specify Apex universal joints. Standard sizes, 1/4" to 4" diameters, covered or uncovered. Full range of hub types. On special applications, send sketch or print for prompt recommendations and quotation.

PHOTOS COURTESY I-T-E CIRCUIT BREAKER COMPANY, GREENSBURG, PENNA.



Metal-enclosed
switching
equipment built
for Southwark
Station,
Philadelphia
Electric
Company, 1946.

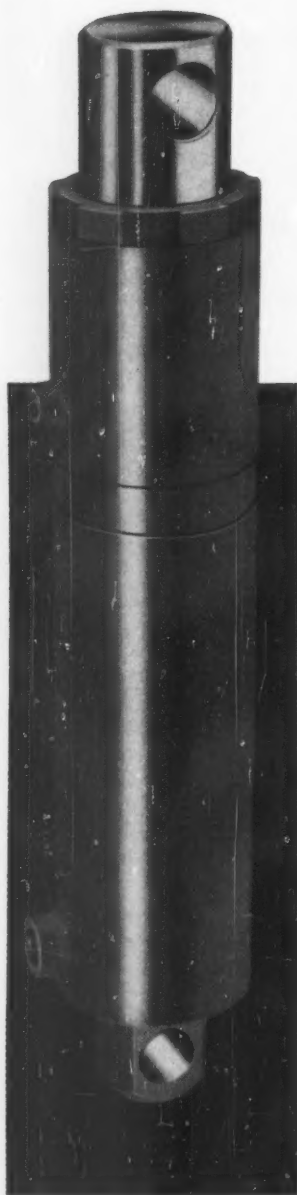


or write, on your company letterhead
please, for Catalog 28 and Data Sheet.



Phantom view of Apex universal joint with lubricant-retaining cover, an exclusive Apex development. Apex covered joints operate efficiently in wet, dry, corrosive or abrasive atmospheres and in extremes of temperature.

CYLINDERS ARE OUR business!



BHEW precision hydraulic cylinders are designed for your job application. BHEW offers the latest developments, designs and manufacturing techniques. You pay only for what you buy and there are no extra or added expenditures. Trained specialists analyze your specific application. BHEW products are available at production prices and are precision-manufactured to produce the highest level of performance.

FOR BETTER ON-THE-JOB RESULTS,
INSIST ON B-H-E-W PRODUCTS!

BHEW Single-Acting General Purpose Cylinders (1500 psi Displacement—Ram Style Series) are designed around standard components but custom-built to your application. They're available in a variety of mountings (pin eye is standard) with or without adjustable or non-adjustable rod ends.

DISCUSS YOUR DESIGN AND APPLICATION PROBLEMS WITH US!



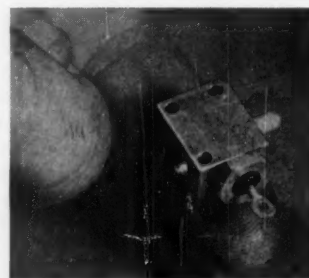
WRITE TODAY for free Hydraulic Cylinder Engineering Reference data. 78 dimensional basic designs for general purpose and special double- and single-acting cylinders. **SAVE TIME!**



- Basic Designs
- Specific Adaptations
- Superior Quality
- Application Engineering

BENTON HARBOR ENGINEERING WORKS, INC.
622 Langley Avenue • St. Joseph, Michigan

NEW PARTS AND MATERIALS



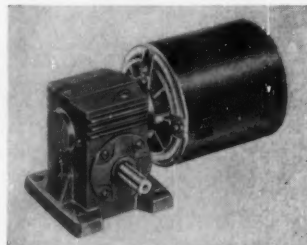
provided. Body of unit shown measures 0.5 x 0.6 x 0.38 in. and weighs 4 grams without leads. Originally designed to trigger the shutter of an impact-proof camera, it has a stroke of 1/16 in. and offers a force output of 3 lb. Actuator fires at 28 v, from an energy input of 15,000 erg. **Propellex Chemical Div., Chromalloy Corp., P. O. Box 187, Edwardsville, Ill.**

Circle 697 on Page 19

Small Speed Reducer

is powered by 1/20
or 0.035-hp motors

Compact assembly for space-saving design features new M109 Ratio-motor. Horizontal right-angle drive is powered by specially designed 1/20 or 0.035-hp motors, and provides a full range of output speeds from 43.8 to 350 rpm. Standard mounting bracket permits easy



mounting in many positions without mechanical alteration. **Boston Gear Works, Quincy 71, Mass.**

Circle 698 on Page 19

Synthetic Oil

for low-temperature
industrial uses

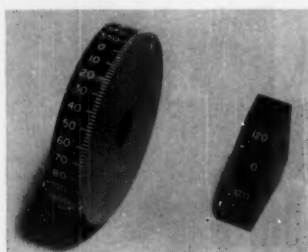
Synthetic oil, designed for extreme low-temperature applications such as chart drives, clock movements, meteorological, and aircraft instruments, is called Anderol L-423. The light-viscosity diester oil features a

pour point below 105 F and viscosity at 90 F of only 5000 centistokes. Lubricant meets the requirements of low starting and running torques over a temperature range of -100 to +250 F. Completely compatible with ordinary lubricants, oil offers penetration comparable to fine penetrating oils. It is also free of water, and a film protects parts from humid or salt conditions. Available in pint, quart, and gallon cans, and 5 or 55-gal drums. Lehigh Chemical Co., Chestertown, Md.

Circle 699 on Page 19

Drum Dials and Verniers

offer exact reading
within 6 sec of a degree



New ultraprecision engraved drum dials and verniers are available in four basic diameters of 1½, 2, 2½, and 3 in. Units are made to MIL Specifications, black anodized with white-filled engraving. They offer exact vernier reading within 6 sec of a degree. PIC Design Corp., 477 Atlantic Ave., East Rockaway, L. I., N. Y.

Circle 700 on Page 19

Slip Clutch

maintains uniform
slip torque

Ball-bearing slip clutch which eliminates galling and maintains more uniform slipping torque has an overall length of only 0.800 in. Slip clutch has application as a safety device in expensive, complex gear trains. Installed in the train as a tensioning device, unit will slip should output rotation be interrupted. Clutch can be set to a predetermined torque value and will maintain this value even after extended periods of slipping. Units are available in 48, 64, 72, 80, 96, and 120 diametrical pitch. Pitch diame-

Another Tough Problem

SOLVED BY
WHITNEY MSL*
SELF-LUBRICATING CHAIN

**Resists SHOCK, STRESS, FATIGUE
ON
Railway Maintenance Machines**

Raising and lowering a 550 lb. nipper assembly on the Racine Seco "Anchor-Fast" Rail Anchor Applicator approximately 18 times per minute puts severe shock, stress, and elongation loads on a chain.

Yet—the standard Whitney MSL Self-Lubricating Chain used on these hard-working track maintenance machines which apply rail anchors to the base of railroad rail to keep it from creeping lengthways, is providing superior performance month after month without a single instance of chain failure!

The chain replaced a steel cable which connected a hydraulic cylinder to the load. Through abuse in the field, the cable would develop kinks or twists that could not be removed, thus affecting the operation of the machine. Some excessive cable wear was experienced.

MSL Chain's built-in lubrication at the 3 critical wear areas provides great inherent strength and superior resistance to shock, stress, and fatigue. The chain remains flexible for life . . . does not bind or freeze . . . requires no maintenance, and provides up to 5 times longer service life than ordinary chain.

Built-in Lubrication at these 3 Critical Areas

Critical Area 1:

PIN—Protective oil film lubricates live bearing area between pin and bushing, minimizing wear by reducing metal-to-metal contact.

Critical Area 2:

PLATES—Oil-impregnated Sintered Steel Bushings extend beyond surface of inside plates to: act as lubricated thrust bearings, control clearance, and provide an oil cushion between plates, eliminating plate galling and seizing frequently caused by misalignment of sprockets.

Critical Area 3:

SPROCKET ENGAGEMENT—Oil film on MSL Bushing exterior provides constant lubrication between sprocket teeth and chain. Whitney MSL Chain requires no rollers, as the tough oil film on the bushing surface provides smooth sprocket engagement, cushions impact and reduces drive wear.

If the drive chain on your product must deliver optimum performance in severe operating environments, or operate with maximum cleanliness, check the advantages of Whitney MSL Self-Lubricating Chain. It is completely interchangeable with any similar pitch ASA standard chain. Write for MSL Chain Catalog today.

*MAXIMUM SERVICE LIFE

THE WHITNEY
a subsidiary of **FOOTE BROS.**
GEAR AND MACHINE CORPORATION



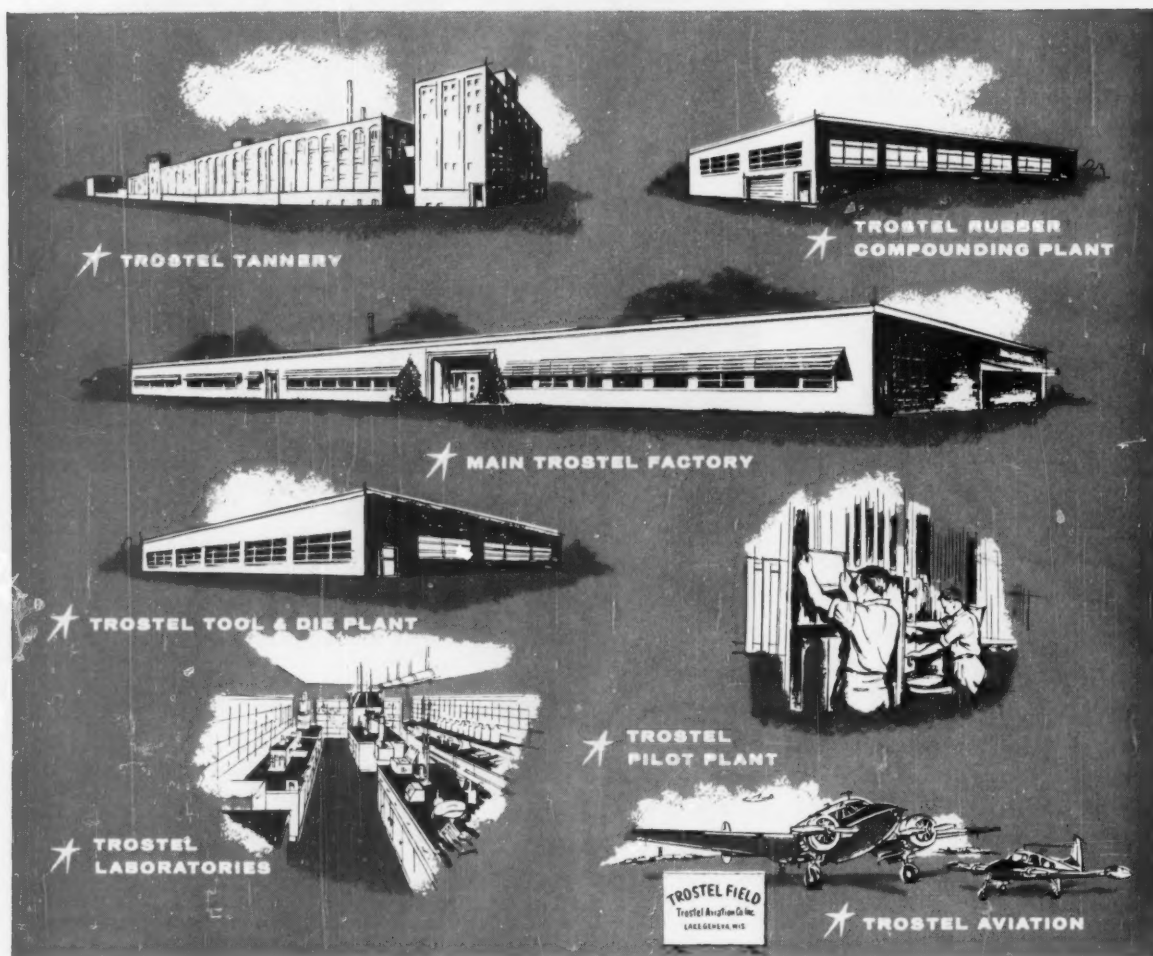
CHAIN COMPANY
4567 S. Western Blvd., Chicago 9, Ill.

POWER TRANSMISSION DRIVES

TROSTEL

A complete producing organization for

☆ OIL SEALS ☆ PACKINGS ☆ O-RINGS



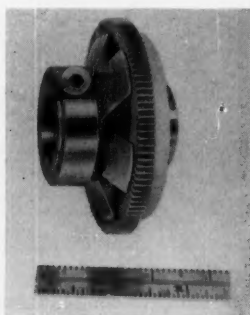
Quality in every phase of supply and manufacture is assured through Trostel ownership of all essential facilities

From raw materials to finished product, all key sources of supply and manufacture are Trostel owned and operated. Leather is tanned at the Trostel Tannery. Rubber is compounded at the Trostel Compounding Plant. Dies are made at the Trostel Tool and Die Works. Three separate Trostel Laboratories conduct research in leather, impregnations, and synthetics. A pilot plant tests all production runs. When, therefore, parts and materials arrive at the point of manufacture into seals and packings they are uniformly standard in specifications. Manufacture itself is by automatic machinery in a modern plant, with a quality control system that insures close-tolerance accuracy in all operations. Special delivery and service are provided by Trostel Aviation . . . we can come to you quickly, or bring you to us.

Trostel control of its products from raw materials to delivery is your guarantee of dependably high quality at all times, on every order. For catalog and technical data, write Albert Trostel Packings, Ltd., 600 Madison St., Lake Geneva, Wis.



PACKINGS
OIL-SEALS
O-RINGS



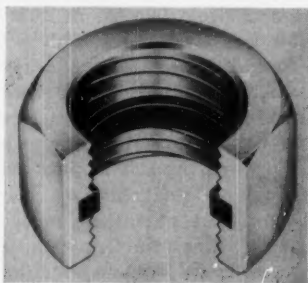
ters are from 0.750 through 2.000 in. with pressure angle of 14½ or 20 deg. Dynamic Gear Co. Inc., Dixon Avenue, Amityville, L. I., N. Y.

Circle 701 on Page 19

Self-Locking Nut

for standard and high-temperature uses

Self-locking nut, called J-Lok, has an internal locking ring. It can be used either side up for automatic assembly and is re-usable. For standard applications, nut is made with an internal locking ring of Delrin or polypropylene; both are flexible, resilient materials. For high-temperature applications, an internal,



spring-steel locking ring is used. Nuts will be available in all standard and commercial sizes. Jacobson Nut Mfg. Corp., Box 177, Kenilworth, N. J.

Circle 702 on Page 19

Miniature Vane Pump

has replaceable vane-pump cartridge

Miniaturized vane pump with integral relief valve and electric motor combination is available for aircraft and space vehicles. The 3.0 lb package occupies approximately 28 cu in. of space. Replaceable vane-pump



A combination of static components forms a highly accurate, maintenance-free, rotation measuring system.

Airpax tachometers make accurate speed measurement exceedingly simple. Installation can be made in a matter of minutes and no adjustments are required. The combination meter pointer permits viewing at a distance; the mirror scale allows precision readings. The power drawn from the line is approximately 1 watt, less than that required by an electric clock. Rugged construction insures long trouble-free life.

Inherent advantages are:

- No moving parts
- No loading of shaft
- High accuracy
- Instantaneous operation
- No mechanical contact



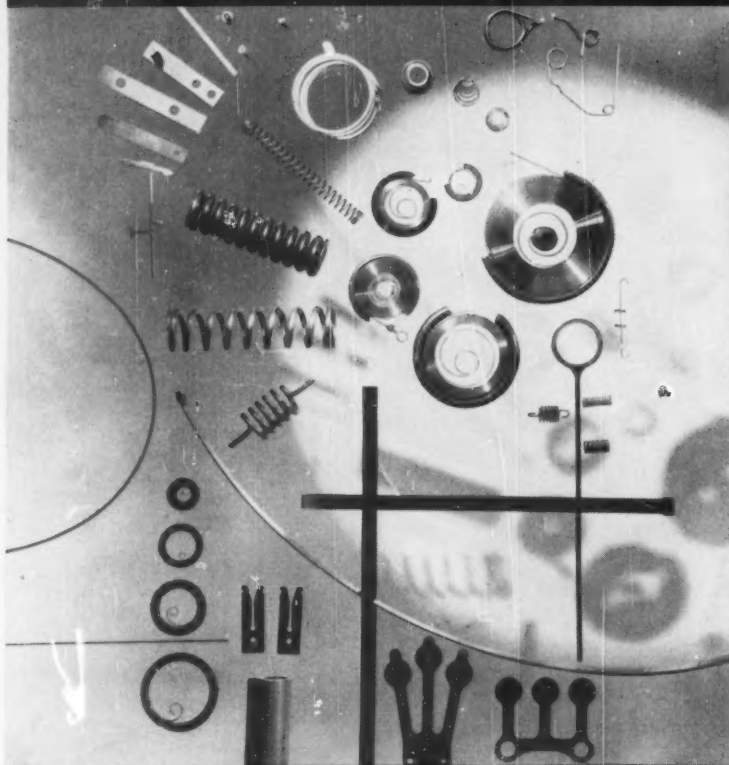
SEMINOLE DIVISION

FORT LAUDERDALE, FLA.

Specify ELGILOY

for components requiring these properties:

- Corrosion-resistance
- Greater spring effectiveness
- Temperature-resistance
- Set-resistance
- Fatigue-resistance
- Non-magnetic

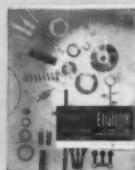


Elgiloy, a cobalt spring alloy, is extremely versatile as the typical parts shown here illustrate.

ELGILOY is a unique new material you ought to know about. It beats corrosion even when stainless steel succumbs. Resists set and fatigue far past the point where carbon steel fails. Elgiloy can be stamped, coiled, blanked, formed, welded, brazed, or soldered. Will keep its "spring" up to +1000°F, and is non-magnetic.

Elgin has the talents and facilities to design and produce an almost endless variety of components in ELGILOY. Investigate this service today!

write for free new booklet Contains tables and comparative performance graphs on ELGILOY, and valuable data on how to work it. Get your copy—see why ELGILOY parts can make your product better than ever!



Abrasives Division
ELGIN NATIONAL



WATCH COMPANY
ELGIN, ILLINOIS

NEW PARTS AND MATERIALS



cartridge simplifies service. Pump alone, or pump in combination with hydraulic or electric motors, has found use in such applications as small radar drives, small computer drives, fuel pumps, missile skin cooling, flow dividers, and pressure lubrication. Pump delivers 1.05 gpm at 90 psig pressure. It is nominally rated for 1000 hr continuous duty at operating temperatures from -65 to +160 F at 11,000 rpm speed. Vickers Inc., Div., Sperry Rand Corp., Detroit 32, Mich.

Circle 703 on Page 19

Electric Motor

provides positive inherent motor protection

Guardistor motor is designed to provide positive inherent motor protection by the use of positive temperature coefficient thermistors. Protection is based on the sensitivity of the thermistors to heat build-up in the motor winding alone, rather than being affected by line currents. Motor can be used for any ac application and protects against overheating due to single phasing, locked rotor, too frequent starting, repeated overloads, high ambient temperatures, abnormal voltage conditions, ventilation failures, switch welding, and plugging or reversing duties. Contactless PTC thermistor is an integral part of the motor; each is encapsulated in epoxy resin before installation in the motor winding. Encapsulation plus motor insulation



HERE'S WHAT ANOTHER FAWICK USER SAYS:

“Maintenance reduced to minimum!

Production increased 25%!

Safety at maximum!”

That's the word from Walt M. Eklund, Maintenance Superintendent at the Kaiser Refractories & Chemicals Division's Basic Refractories Plant, Moss Landing, California. Kaiser Refractories used FAWICK Airflex Clutches to replace mechanical units which were not adapted to the continual starting and stopping necessary for pressing brick. Simplified drum-type design and automatic adjustment of the FAWICK units have minimized maintenance expense and substantially increased production.

In this brick pressing operation, the operator must see that the mix of chrome and periclase discharges into the mold, operate the press to compress and shape the brick, then remove it by hand. Actuation of the press through the FAWICK Clutch is by push-button control, adding greatly to production speed. Simultaneous release of the clutch and application of the brake are accomplished through controls actuated by interrupting a beam from three photo-electric cells mounted on the front of the press. This feature provides maximum safety against re-cycling of the press in case the operator tries to remove the shape too soon or too late.

This application of advanced power-transmission techniques shows how FAWICK can help you gain production profits by increasing machine operator efficiency and improving safety. Get full information from your nearest FAWICK Representative, or contact the Home Office, Cleveland, Ohio.

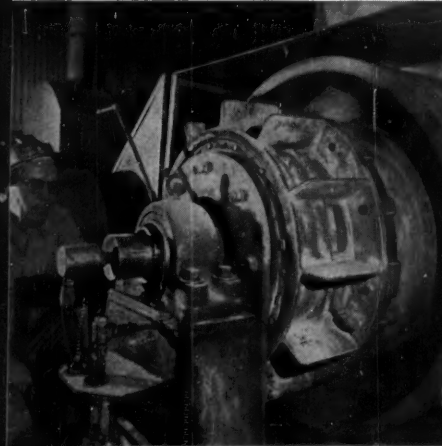


Circle 515 on Page 19

Walt M. Eklund, Maintenance Superintendent, and bricks produced on Fawick-equipped International Brick Press, the first of which was converted to Fawick Clutches in 1954.



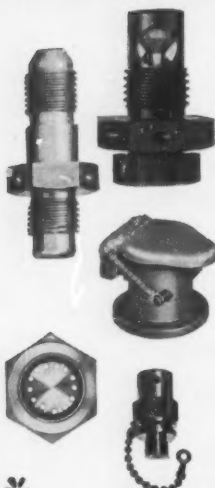
FAWICK AIRFLEX DIVISION
FAWICK CORPORATION
9919 CLINTON ROAD • CLEVELAND 13, OHIO
Fawick Canada, Ltd., 60 Front St., West, Toronto, Ont., Canada.



FAWICK 20CB500 type CB Airflex Clutch (under fly-wheel rim) and FAWICK 21.5-E4.75 type E Air-Ring Brake provide International Press with precision operation and freedom from maintenance under heavy duty service.



Accurate stopping during custom brick production is an important safety factor in brick making, where compressed bricks are removed from the press by hand. Interrupting beam from photo-electric cells (right) simultaneously disengages clutch and engages brake without danger of accidental re-cycling.

TEDECO*Aviation Grade***GEAR CASE ACCESSORIES***

*
SEND FOR OUR
CATALOG 3-60

- **SELF CLOSING CHIP DETECTOR DRAIN PLUGS**

MAGNETIC—Provide quick, convenient visual inspection, no fluid loss, no special tools nor electric gadgets. Matching drain and fill hoses available.

ELECTRIC—Combines self closing features with new magnet-contact arrangement for greater reliability. For panel signal, or probe, plus easy visual inspection.

- **BREATH VENTS**

Conform to aircraft specifications. Full line of sizes and types for normal use, outside venting or for inverted flight.

- **GEAR CASE FILLER CAPS AND PLUGS**

Caps are precision made of die cast aluminum. Snap closed—stay closed. Snap open—stay open. Filler plugs with matching filler lines.

- **LIQUID LEVEL SIGHT GLASSES—OBSERVATION WINDOWS**

Easy installed in tapped hole. Reflector assures visibility in liquid level sighting. Available without reflector for observation purposes.

- **SPECIAL PRODUCTS**

Design and manufacturing facilities available for production quantities of adaptations of our present line, for special models, or for products of similar nature.

TECHNICAL DEVELOPMENT COMPANY

GLENOLDEN, PA.

Circle 516 on Page 19

LUDLOW 3-3330



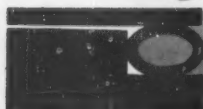
Write for free 22-page booklet (on your letterhead please).

**tiny holes assure
pressure tight seals
United's exclusive
patented feature**

United's exclusive, patented* self-energized metallic O-rings have tiny holes in the hollow ring wall. The holes are to balance the interior and exterior pressures in order that the ring may respond to variation in deflection of the sealing surfaces with a natural resilience uninhibited by the external pressure.

In metal-to-metal applications, self-energized metallic O-rings are capable of forming positive, permanent, non-corrosive, static seals under extreme temperatures from -321°F. to 1800°F. , and under pressures equal to ultimate compression stress of the metal itself. Available in various metals and finishes, $\frac{3}{16}$ " dia. to any size or configuration. United also makes non-vented and pressure-filled O-rings; and wire and brazing O-rings.

PATENTS 2,809,269; *2,837,360



UNITED METALLIC "O" RING CORP.

Dayton, Ohio • Box 1035
Division of United Aircraft Products, Inc.

NEW PARTS AND MATERIALS

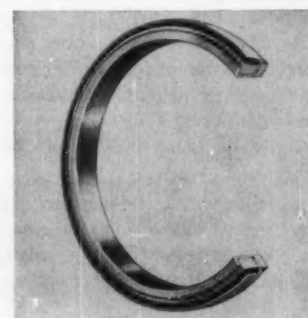
provide resistance to moisture, chemicals, and oils. Thermistor is not affected by temperature until it reaches its predetermined critical temperature which is designed for the limitation of each insulation class and enclosure. At the predetermined temperature, thermistor has a 100 to 1 positive change in resistance versus temperature, giving snap-action-type response. **Westinghouse Electric Co., P. O. Box 2099, Pittsburgh 30, Pa.**

Circle 704 on Page 19

Ring Seal

for use at
high temperatures

Nonsplit, hydraulic and pneumatic linear-motion ring seal with all-metal construction permits use at temperatures from -425 to 1500°F. Seal consists of a metal lip of special design and configuration, fastened in a stainless-steel ring. Ring sup-



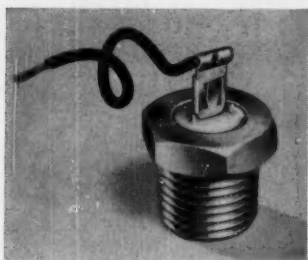
ports the lip in axial direction and prevents blowout under extreme pressures. Seals are available in a standard series and as a double unit. **Gits Bros. Mfg. Co., 1866 S. Kilbourn Ave., Chicago 23, Ill.**

Circle 705 on Page 19

Temperature Control

has exceptional
vibration resistance

Snap-acting temperature control for marine and industrial applications features exceptional vibration resistance with long life. Type PT is used as a high-limit or controlling thermostat. Other features include rapid temperature response, free calibration, sealed construction, and constant thermal and electrical contact. The SPST unit is rated 3 amp



at 32 v, grounded. Temperature setting range is -65 to +325 F. Therm-O-Stats Inc., Box 303, Chartley, Mass.

Circle 706 on Page 19

Damping Compound

reduces structurally borne noise and vibration

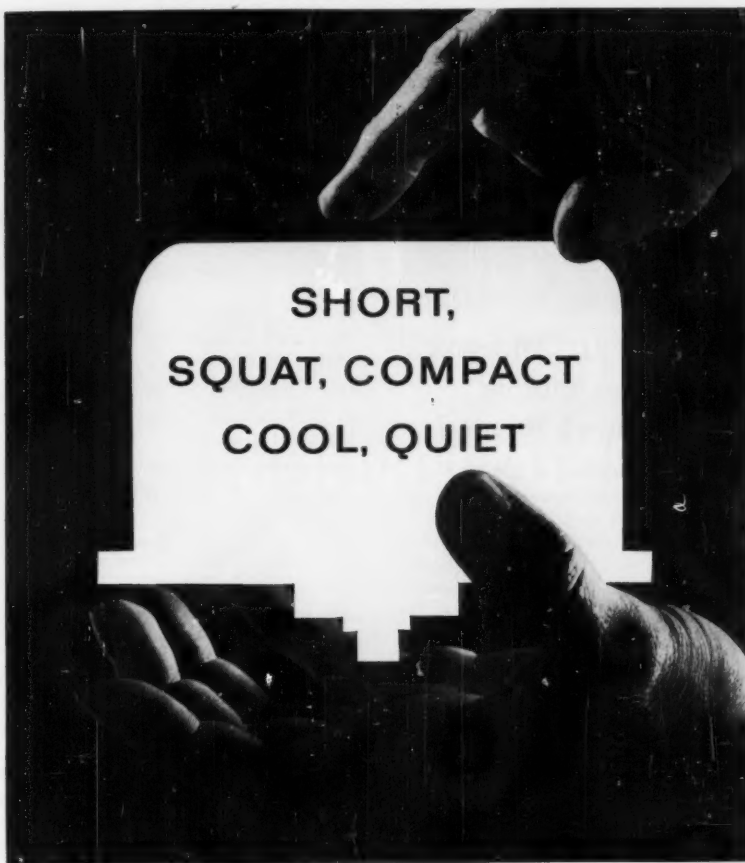
Vibrodamper viscoelastic material, when sprayed or trowelled onto metal plate, drastically reduces structurally borne noise and vibration. It renders metal plate acoustically equivalent to a sheet of cork. Material provides a vibration decay rate of 35-55 db. It is also 100 times as effective for vibration damping as a 1/2-in. thick, 6-lb density, glass-fiber blanket. Compound is handled like a coat of paint, dries to a smooth, attractive finish, is nontoxic and nonflammable. It resists alkali, grease, gasoline, and aliphatic oils, and is unaffected by ozone or sunlight. It has an extremely long effective life, and does not become brittle or change in any way with age. Korfund Co., 48-19D 32nd Place, Long Island City 1, N. Y.

Circle 707 on Page 19

Check Valve

for use where high surge flows are present

Series 200 check valve positively assures O-ring reliability against high-pressure, split-second surge flows. Foolproof O-ring retention is assured by cage device which positively restrains O-ring from wash-out. Heavy, rugged construction of body provides additional protection against abuse and failure. Valve also provides dead-tight sealing and chatterfree operation, proper cushioning combined with low pressure drop, and dependable, sensitive,



...with torque that's terrific

This Jack & Heintz motor is the perfect power package for laundry equipment, air wall ventilators, machine tools, pumps. (You'll find it right now on every major make of floor polisher.)

We can modify it to fit *your* specs, and add such specials as an exterior contour and finish to match the styling and color you've designed for the original equipment. Externally or internally mounted capacitor (3/4 through 1 1/2 hp—or higher ratings on request). Single or dual voltage, single or three-phase, special current characteristics. With or without special face or flange-mounting end frames.

We'll design and produce, to your specs:

- complete motor
- 3/4 motor kit (rotor, stator and switch end bell)
- motor kit (rotor and stator)

WRITE TO:

JACK & HEINTZ, Inc.

COMMERCIAL MOTOR DIVISION
17626 Broadway • Cleveland 1, Ohio



Eastman 910 Adhesive solves another production bottleneck

Hilliard Corporation, of Elmira, N. Y., manufacturers replaceable oil-filter elements for military and industrial use.

The element consists of a perforated metal tube surrounded by a pleated paper cylinder. The paper cylinder is held tightly against the tube with snug-fitting paper retaining bands.

Vital to proper filter operation, the bands are formed by wrapping a strip of wax-impregnated paper around a mandrel, then overlapping the dewaxed ends and bonding them together with a drop of Eastman 910 Adhesive.

Use of this fast-setting adhesive reduces the time for this operation by 50% compared with a hot iron heat-sealing method employed formerly.

Eastman 910 Adhesive is making possible faster, more economical assembly-line operations and new design approaches for many products. It is ideal where extreme speed of setting is important, or where design requirements involve joining small surfaces, complex mechanical fasteners or heat-sensitive elements.

Eastman 910 Adhesive is used as it comes. No mixing, no heating. Simply spread the adhesive into a thin film between two surfaces. Light manual pressure triggers setting. With most materials, strong bonds are made within minutes.

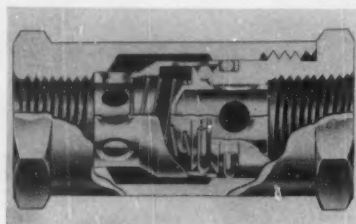
What production or design problem can this unique adhesive solve for you?



For a trial quantity (1/3-oz.) send five dollars to Armstrong Cork Co., Industrial Adhesives Div., 9106 Dean Street, Lancaster, Pa., or to Eastman Chemical Products, Inc., Chemicals Div., Dept. M-6, Kingsport, Tenn. (Not for drug use) See Sweet's 1960 Prod. Des. File, 7/E

Circle 519 on Page 19

NEW PARTS AND MATERIALS



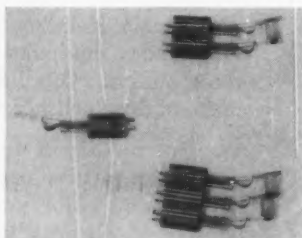
leakfree reseating. It is suitable for use in a variety of high-pressure gas or liquid services where extreme surge flows are encountered. Bodies of brass, aluminum, steel, and stainless steel are available in 1/8 to 2-in. pipe sizes. Circle Seal Products Co. Inc., 2181 E. Foothill Blvd., Pasadena, Calif.

Circle 708 on Page 19

Snap-Action Switch

miniature unit has
wiping action

Open-blade, miniature, snap-action switch is available in single, double, and triple-pole units. Double or single-throw, set or return types are available in up to four poles. Switch is thin, so that two and three-pole stack-ups in a narrow space meet interior limitations of small black boxes. Unit is equipped



with wiping action. Electrical ratings are 125 v ac, 5 amp; 250 v ac, 2.5 amp. Columbus Electric Mfg. Co., 2005 E. Main St., Columbus, Ohio.

Circle 709 on Page 19

Rotary Steppers

achieve stepping
action magnetically

Series 18500 all-magnetic positioning stepper devices are designed for precise angular positioning of rotary components such as potentiometers, dials, and indicators. Units can be coupled to synchro transformers or predetermined pulse counters. Step-

**FROM DESIGN TO
PRODUCTION LINE
QUICKLY WITH**



ALUMINUM and GREY IRON CASTINGS

Your design becomes a practical reality with superior castings from Gillett & Eaton, nationally known piston manufacturers. High alloy grey iron castings, aluminum and hypereutectic alloys in sand, semi-permanent or permanent mold. Complete pattern shop, tool room, x-ray and heat treating facilities, modern laboratory and piston machining facilities. Quality castings to your specifications—at a competitive price. Write for our quote.



GILLETT & EATON, Inc.

860 Doughty Street, Lake City, Minn.

Sold in Canada by
Gould National Batteries of Canada, Ltd.
Fort Erie, Ontario

Piston and casting specialists

Established 1868

Circle 520 on Page 19





NOTICE!

60 Second Contact Convertibility

ALLEN-BRADLEY CONTROL RELAYS

can thus easily be changed
from N.O. to N.C. (or vice versa)

Why not give yourself a real surprise! We refer to the ease with which you can convert the contacts of these Allen-Bradley Bulletin 700 Type BR control relays. Using only a screwdriver, contacts can be changed from normally open to normally closed (or vice versa) in seconds—without removing the relay from its mounting—or its wiring. This “on-the-spot” convertibility certainly suggests an appreciable moneysaving reduction in your relay inventories.

Extensive tests have proven conclusively that the Bulletin 700 Type BR relays are good for many—and we mean *many*—millions of trouble free operations. A “built-in” permanent air gap completely eliminates all possibility of magnetic sticking. Naturally, the double break, silver contacts never need attention. Also, the molded coil is your assurance that even the most severe atmospheric conditions cannot cause trouble. Please write for full details on these relays today!





BUT HEAR THIS!

In the event that when “on-the-job” it is discovered that something was either overlooked or added, the standard Bulletin 700 Type BR—either 2, 3, 4, or 6 pole relay—can easily have added to its base, out in the field, either one or two switching poles. It is done as easily as “falling off a log.”



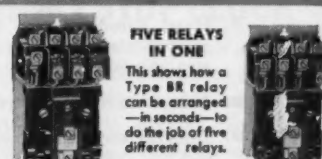
General-Purpose
NEMA 1



Explosion-proof
NEMA 7




Waterproof
NEMA 4

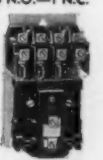


**FIVE RELAYS
IN ONE**

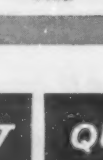
This shows how a Type BR relay can be arranged—in seconds—to do the job of five different relays.




3 N.C.—1 N.O.




3 N.O.—1 N.C.



4 N.C.



2 N.O.—2 N.C.



4 N.O.

ALLEN-BRADLEY

Member of NEMA

Allen-Bradley Co., 225 N. First St., Milwaukee 4, Wis. • In Canada: Allen-Bradley Canada Ltd., Galt, Ont.

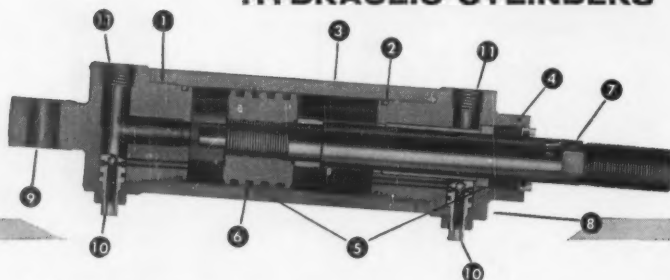
**QUALITY
MOTOR
CONTROL**

DESIGN ENGINEERS



You get ALL 12
only with *Pathon*

HYDRAULIC CYLINDERS



1. Heads retained with a single screw thread for maximum strength, rigidity and minimum size.
2. O-ring head seal in close fitting pilot. Long Pilot maintains concentricity.
3. Heavy wall seamless steel tubing for strength allows generation of precision bores.
4. Multi-lip packing for longer life — externally replaceable. Rod bearing inboard to packing where it gets lubrication.
5. Relatively long span between piston and rod support resists side loads with reduced unit bearing force. This eliminates need for "stop tubes" even on long stroke cylinders.
6. Either standard ring type or U-cup type piston available. Both may be readily installed without special tools or collapsing devices.
7. Hard chrome-plated piston rod standard. Hardened and chrome-plated alloy steel rods, ground after hardening for straightness, optional.
8. Minimum mounting area required on all end mounted units.
9. Integral mounting pads for rigidity and permanence. No welding, no brackets.
10. Cushion adjustment requires only 180° turn from full open to full closed. Makes setting cushions easy. Equipped with locking nut. No change of position after setting.
11. Ports may be located in any position relative to each other.
12. No tie-rods to stretch, or tie-rod nuts to coin into the heads under heavy loads.

Pathon Hydraulic Cylinders are available in nine mounting types, thirteen bore sizes—1½" through 14", and three Series—for 1,000, 2,000, 3,000.

WRITE FOR BULLETIN 22A P.S.I.

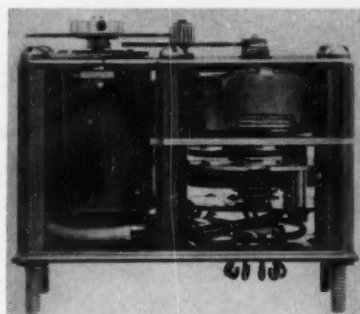
Pathon

MANUFACTURING COMPANY

3823 PACIFIC AVE., CINCINNATI 12, OHIO

FLUID OPERATED AND CONTROL EQUIPMENT

NEW PARTS AND MATERIALS



pers operate on the number of pulses received, not on changes in phase angle or voltage, and stepping action is achieved magnetically, without ratchets, linkages, or contacts. Devices meet or exceed military requirement MIL-E-5272C. A. W. Haydon Co., 232 N. Elm St., Waterbury, Conn.

Circle 710 on Page 19

Metallized Paper Capacitors

have high resistance
to heat and moisture

Type MPA plastic-molded metallized paper capacitors are fully insulated and have high resistance to heat and moisture. Virtually indestructible casing affords complete protection against severe usage. It will not dry out or develop cracks or fissures. Capacitors have a rectangular shape which allows greater parts density. A 4.0-mfd unit measures only 37/64 x 3/4 x 1 3/4 in. Capacitors are easily identified by their blue color. Stand-



ard units can be supplied from 0.005 to 4.0 mfd, and higher capacities are available. Hopkins Engineering Co., 12900 Foothill Blvd., San Fernando, Calif.

Circle 711 on Page 19

Vinyl Dispersion Resin

imparts desirable flow
and gelatin characteristics

Specialty vinyl dispersion resin, Plovic WO, is available for compounding quality plastisol and organosol

formulations for a variety of end-use applications. It imparts highly desirable flow and gelatin characteristics to compounds for knife, roller, and dip coating, plastisol gasketing, roto-cast, and slush molding. Products made of the plastisols exhibit excellent ultraviolet, abrasion, chemical, and water resistance and good flex life. Excellent adhesion to many surfaces, good heat and light stability, and improved electrical properties are other advantages possible through use of the resin. High molecular weight results in good strength. Chemical Div., Goodyear Tire & Rubber Co., Akron 16, Ohio.

Circle 712 on Page 19

Container Latch

has ultimate tension and shear strength of 4500 lb



Heavy-duty container latch for rugged service, designated 37L, is for use on reusable containers, transit cases, and large assemblies of components. Latch has an ultimate tension and shear strength of 4500 lb. Two models are available, one 5¼ in. long and the other 3⅞ in. long. One provides more mechanical advantage with less take-up; the other provides more take-up and less mechanical advantage. Latch has only five parts, and is available with either steel or aluminum mounting pads and hooks. Camloc Fastener Corp., 22 Spring Valley Rd., Paramus, N. J.

Circle 713 on Page 19

Rotary Switch

for use in limited-space applications

Snap-in rotary canopy switch is designed for use on lamps and small appliances where limited space is a consideration. Switch is available with nickel or brass-finished, multi-fingered steel clip. Easily snapped

STOP!



Look what happened when A. W. Haydon designed a new LABORATORY STOP CLOCK

You just won't find these features in any other stop clock. This versatile timer-of-all-work was designed by engineers who understand timers and timing...and who needed a precise time reference in their own work. **Timed outlet**—energized whenever clock runs, supplies 115V, 60 CPS, 3 amp to time and control external loads simultaneously...manually or automatically. **External Run Socket**—for remote running, using a control cable...manually or automatically (when wired into a system). **Clutchless timing mechanism**—needs no warm-up, make-ready or pre-start. Synchronous motor starts and drives instantly. No power consumed except during timing and reset. **Independent RUN and RESET** buttons for manual, local control. **Schematic diagram** and control circuitry silk-screened on bottom of housing for ready reference. ■ Bench type precision stop clocks are available with optional remote control for manual or automatic running and/or resetting. Clocks operate on commercial 115V, 60 CPS power; accuracy is ± 25 milliseconds.

Low power drain: only 2 watts, timing. Sweep second scale calibrated in 10 millisecond increments; totalizer scale calibrated in seconds, up to 1 min. Sturdy instrument case requires only 4¼" square bench space. For complete specifications, write for Bulletin ET-702. Ask also about panel-mounting versions.



THE AWHAYDON COMPANY
249 North Elm Street, Waterbury 20, Connecticut



"Master-mite"

*the specs
tell the
story*

Pressure: to 540 psi.

Ten orifice sizes: $\frac{3}{64}$ " through $\frac{1}{4}$ ".

Wide voltage range: standard with 115V. AC.; also 12, 24, 208, 230, 460V. AC. 50/60 cycle.

Body: brass bar stock or 18-8 stainless steel. All moving parts, stainless. Seat disc, synthetic rubber. Sizes, $\frac{1}{8}$ " and $\frac{1}{4}$ " NPT. Both conduit and grommet types.

Underwriters' listed as a safety valve

Yes, "Master-mite" is the mighty mite of solenoid valves. Useable on a wide range of media including hydrogen, acetylene, etc. Works right in any position. Small, but with extra strength in the Marsh manner. Coils never overheat. Leak tight. Remarkably quiet.

Ask for special bulletin

MARSH INSTRUMENT COMPANY
Division of Colorado Oil & Gas Corporation,
Dept. B, Skokie, Ill. Marsh Instrument
& Valve Co., (Canada) Ltd., 8407
103rd St., Edmonton, Alberta, Canada.
Houston Branch Plant, 1121 Rothwell St.,
Sect. 15, Houston, Texas.

MARSH

GAUGES • THERMOMETERS
VALVES

Circle 524 on Page 19

NEW PARTS AND MATERIALS



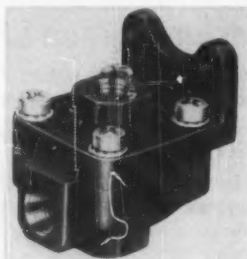
into a keyed mounting hole, switch is mounted and locked into position with a single push. Switch is available in black, brown, or white. Circle F Mfg. Co. Inc., Tyler and Monmouth Streets, Trenton 4, N. J.

Circle 714 on Page 19

Air Shuttle Valve

contains only one moving part

Air shuttle valve selects and directs flow of air from one or the other of two controlling devices to a common outlet. Extremely sensitive, only 1 psi pressure differential will seal off low-pressure line and connect higher pressure line to outlet. Valve contains only one moving part, an easily replaceable rubber diaphragm. Made of die-cast aluminum and weighing only 6 oz, it can easily be supported by piping alone. Mounting feet are included for installations with vibration or long pipe



runs. Available with $\frac{1}{8}$ or $\frac{1}{4}$ -in. NPT ports, valve is suitable for a maximum air pressure of 200 psi. Operating temperature range is -40 to +160 F. Industrial Products Div., Westinghouse Air Brake Co., Wilmerding, Pa.

Circle 715 on Page 19

Small Fuel Pump

incorporates hand primer

Midget fuel pump features a hand primer that eliminates need for en-

THE RIGHT COMBINATION FOR BETTER TUBING



YOU GET ALL IN PRECISION TUBING

**Sizes .010" O.D. to 1.125" O.D.
Copper, Brass, Nickel Alloys**

● If you want to unlock the way to better product quality specify Precision Tubing. Every pound, every foot, every size or shape is made to meet the most exacting requirements and performance tests.

Precision Tubing can be produced to meet your specifications from annealed to full hard. Scientific inspection carefully checks to the Nth degree for absolute accuracy. Precision Tubing is available in clean, scratch-free finishes suitable for anodizing or plating to mirror finishes. All of this Precision Control of quality is yours at regular mill prices.

Whether you need copper, brass, aluminum, nickel or nickel alloy tubing you are sure of proved unsurpassed quality from Precision. Write for complete technical catalog to

PRECISION TUBE CO., INC.
North Wales, Pa.

Get Your Free Copy



Circle 525 on Page 19



"ALCOA ALUMINUM SCREW MACHINE STOCK ALLOY 6061... FOR VERSATILITY!"

Precision-made, high-volume screw machine parts cost less in aluminum

Here's versatility! Alcoa Alloy 6061-T6 or -T651, being lightweight aluminum, gives you three times more parts per pound than other, heavier metals. And this alloy gives superior finishes... can be joined easily by welding, brazing or soldering... may be anodized in a wide variety of colors... stands up to service under corrosive conditions! Machining speed, light weight and end-use adaptability... all add up to faster production, lower machining costs, higher profits.

Want to make cost conversions from brass to aluminum and compute costs quickly? Ask your Alcoa distributor or Alcoa sales office for your free *Alcoa Conversion Calculator*. Get your free *Alcoa Screw Machine Stock Estimating and Operating Data Book*, too... packed with technical data on aluminum screw machine stock. And ask about other Alcoa alloys: 2011-T3 or -T8 for superb machinability and still faster cutting, 2017-T4 or -T451 and 2024-T4 or -T351 for strength at

low cost. Aluminum Company of America, 840-F Alcoa Building, Pittsburgh 19, Pa.

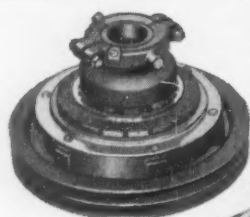
AS AN ALCOA CUSTOMER, YOU GET ALL THESE "EXTRA BONUSES":

1. Wide range of stock sizes for important price advantages.
2. Guaranteed market for up to 60 per cent of your Alcoa® Aluminum turnings and borings.
3. Extensive mill and distributor inventories to meet all requirements.
4. Chamfered ends at no extra cost.
5. Specific 12-ft lengths at no extra cost (for rounds up to 2 3/4 in.; hexagons up to 2 in.).



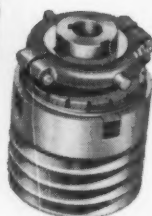
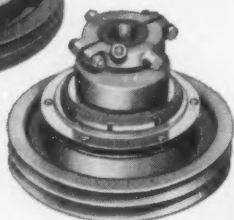
ALCOA ALUMINUM

SCREW MACHINE STOCK



Did Someone say Sheave Clutches?

Here's a graceful line-up of just a few standard models — many more available, of course.



Torques range from 90 to 3200 pound inches—higher, if needed.

Also available with the fabulous Stationaire.

Living proof of the versatility of Conway Clutches—for every industry.

WRITE FOR BULLETINS About the world's most respected name in clutches for over a half-century.



The CONWAY CLUTCH COMPANY

2750 Colerain Ave.

Cincinnati 25, Ohio

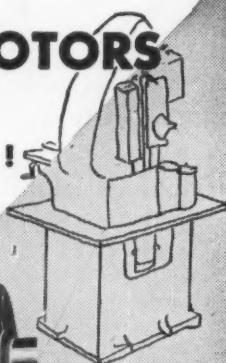
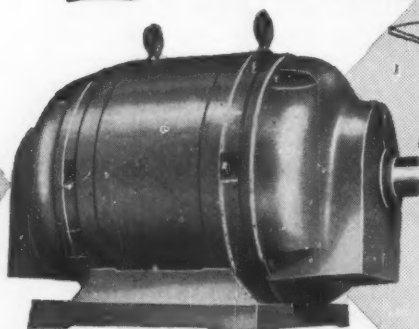
Circle 527 on Page 19

VALLEY BALL BEARING MOTORS

Custom Built . . .

NOT Custom Priced!

AIR
COOLED



- POLYPHASE, 50 OR 60 CYCLES
- SQUIRREL CAGE INDUCTION
- HIGH TORQUE
- ½ TO 75 H.P.

Cool Running . . . Continuous Service . . .

that's the axiom Valley Motors live up to.

They have been tested and proven in every industry where dependable service and power is a requirement. Remember they are semi-enclosed to assure protection against dripping or splashing liquids, metal chips and abrasive dust.

WRITE FOR COMPLETE INFORMATION

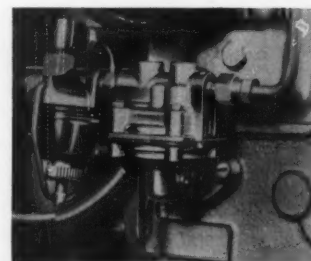
VALLEY

ELECTRIC CORPORATION

4221 Forest Park Blvd. • St. Louis 8, Mo.

NEW PARTS AND MATERIALS

gine cranking to provide prime after dry tank is refilled. Simple finger action provides positive fuel feed to carburetor. Pump has four parts, providing a highly flexible capability. Positioning of the four ports also removes need for angle fittings. Pump provides fuel lift of 4½ ft at 1800 rpm (900 pump strokes per minute) with 2½ gph free delivery. Pump is for use with gasoline or diesel engines with up to 100 cu in. displacement. It is useful in many applications, including service down to -65 F. Unit is 2⅝ in. high, 2



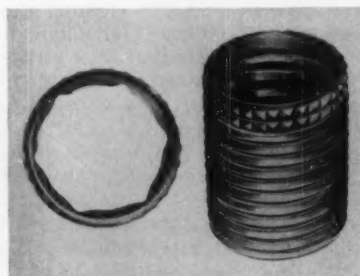
in. wide, 2 in. deep. D. W. Onan & Sons Inc., 2515 University Ave. S.E., Minneapolis 15, Minn.

Circle 716 on Page 19

Thin-Walled Insert

is lightweight and corrosion resistant

Slimsert insert is a minimum-size, lightweight, internally-externally locked, easily installed and removed, high-strength, corrosion-resistant insert. Configuration is unique because of extremely thin wall. Insert is intended for original design, or as a direct replacement for wire-type inserts. It is easily installed with a hex wrench and locked against rotation by swaging serrated head into parent material. Internal thread lock positively secures engaging bolt or screw, even after countless insertions and removals. Insert is



available with internal thread sizes from No. 10 through $\frac{1}{2}$ in. diam. Rosan Inc., 2901 West Coast Highway, Newport Beach, Calif.

Circle 717 on Page 19

Silicon Diode

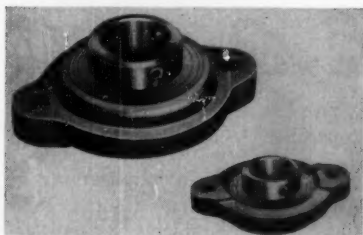
for airborne and industrial computers

Diffused silicon diodes in two major classifications—fast-recovery and high-conductance types—are designed for airborne and industrial computers. Typical applications include switching, pulse, flip-flop, modulator, demodulator, discriminator, clamping, gating, and detector circuits. Fast recovery types provide 400,000 ohms in 1.0 μ sec. High-conductance types feature a maximum average forward current of 100 ma at 1.1 v. Rugged construction provides resistance to shock and vibration exceeding MIL-STD 202A. CBS Electronics Div., Columbia Broadcasting System Inc., 100 Endicott St., Danvers, Mass.

Circle 718 on Page 19

Bearing Units

incorporate new contact seals



Series L bearing units now incorporate a contact seal for applications where the characteristics of a seal are desired. Seal consists of a three-part assembly which presses on the ID of the outer race. Inner flinger rides in close running clearance with OD of inner race. Outer flinger consists of a solid circular ring. Two flingers hold in position a Buna-N-coated fabric washer that has an interference fit on OD of inner race. Bearing units are available in pillow blocks and two or three-bolt flange models for flush or recessed mountings. Bearings and bearing units are available in $\frac{3}{4}$, $\frac{7}{8}$, 15/16, 1, $1\frac{1}{8}$, $1\frac{3}{16}$, $1\frac{1}{4}$ (special), $1\frac{1}{2}$

June 23, 1960



TURN THE
KNOB,
CUSTOM-MAKE
A RELAY

This time-delay relay you make to your own timing specifications. It's electrically adjustable. You can tune it directly or remotely to any delay you want between half a second and half a minute. At any time-delay setting, you can expect repeatability within $\pm 5\%$. Reset is instantaneous. ☐ The relay operates on 12 volts DC. With a voltage divider kit, which we supply, you can fix it to work on 24, 28, or 48 volts DC. Switching is S.P.D.T. ☐ The cost of this transistor-controlled relay will surprise you. It's definitely in the commercial class, if you buy in production quantities. ☐ Bulletin 5300-B will give you full technical details. Yours for the asking, of course.

HEINEMANN ELECTRIC COMPANY

172 PLUM STREET



TRENTON 2, N. J.

SA-2209

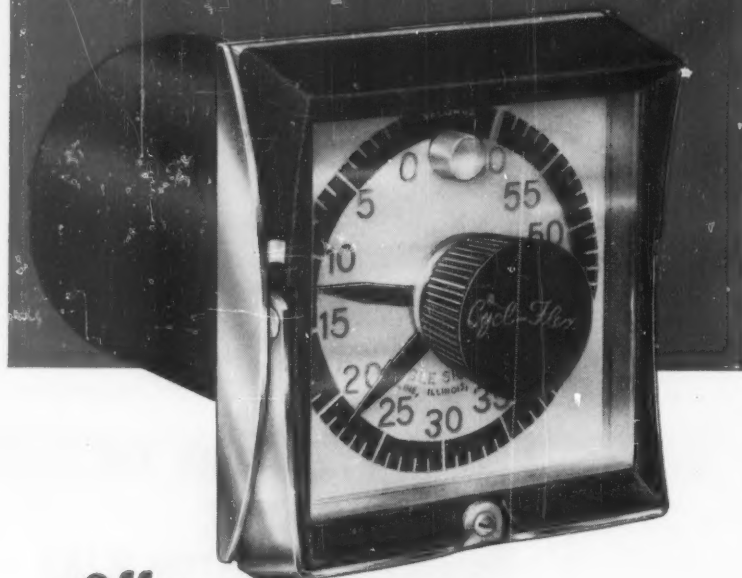
Circle 529 on Page 19

213

new plug-in timer

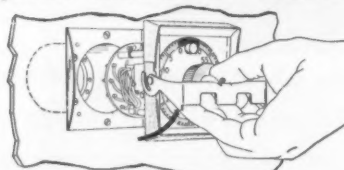
for controlling industrial processes

EAGLE'S HP5 CYCL-FLEX



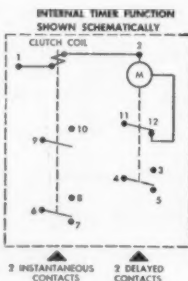
Offers:

- Fast, easy installation
- Quick change of time ranges
- Quick means of localizing trouble



To Remove: Lift handle and pull out

With 4 switches — 2 switches operate instantly when timer is energized — 2 switches operate with time delay — delay time adjustable — selection of dials from 10 seconds to 60 hours. Dept. MD-660.



EAGLE



SIGNAL COMPANY

Moline, Illinois

The Most Complete Line of Time-Count Controls

NEW PARTS AND MATERIALS

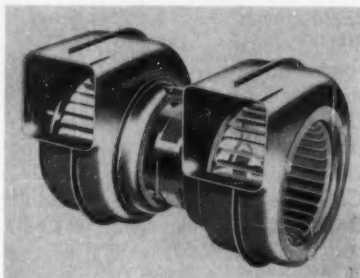
(standard), 1 5/16, 1 3/8, and 1 7/16-in. shaft sizes. Sealmaster Bearing Div., Stephens-Adamson Mfg. Co., Ridgeway Avenue, Aurora, Ill.

Circle 719 on Page 19

Blower Packages

provide high air deliveries

Air deliveries of 800 cfm are available in Type AO blowers. Self-contained power packages feature high air deliveries in low-cost units. Blowers are available in single and double units, 115 or 230 v, 60 cycles. Odd voltages and frequencies can also be obtained. They are suitable



for business machines, vending machines, and applications in the heating, air conditioning, refrigeration, and appliance industries. Redmond Co. Inc., Owosso, Mich.

Circle 720 on Page 19

Air-Damping Dashpot

provides friction-free performance

New models and applications of Airpot air-damping dashpot solve three control problems: System stabilization, vibration damping, and time delay. Weighing less than an ounce, they are constructed of a graphitized carbon piston and low-expansion glass cylinder, ground and fitted to tolerances of 0.0001-in. to attain virtually friction-free performance. Standard unit provides equal damping in two directions, useful where the application does not require fast reset time. Other models are capable of one way damping (either push or pull). Damping is adjustable with a screwdriver or can be factory-preset. Typical applications include: Damping of Regohm voltage regulator, time delay in switch gear, speed control

300 HOUSINGS PER HOUR

produced on Greenlee machine—
*with assist from **VICKERS** hydraulics*

Here's a Greenlee transfer machine that produces 300 steering gear housings per hour while performing a total of 114 close tolerance machining operations. This outstanding performance record is achieved because the machine combines advanced design ideas with the best available components.

Self-contained Vickers hydraulic power packages provide controlled power for clamping the pallet-mounted workpieces in precise position at each work station, driving transfer mechanisms and for movement of certain machine heads. These power packages are designed to JIC (Joint Industry Conference) standards which means easy maintenance and minimum downtime to you.

Vickers offers you power packages, either standard or custom engineered that provide an almost unlimited number of choices to meet your specific technical requirements. You can choose from the broadest product line in the industry any combination of controls for use with single, double, two-pressure or two-stage pumps (the latter for pressures to 2000 psi), and for variable and constant delivery pumps to 5000 psi. Your choice of components will be packaged with the size or shape reservoir best suited for your job.

Whether the Vickers power package you choose is standard or custom engineered, you save money and time because it comes *ready-to-go*—designed and assembled to the highest standard of quality by hydraulic specialists.

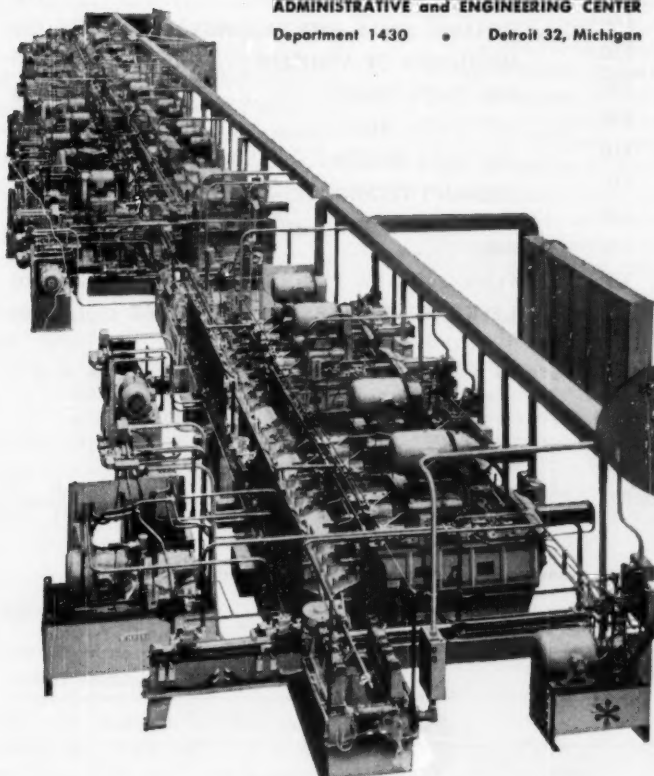
Get more data by writing today for Bulletin 5001C or by consulting your nearby Vickers application engineer.

VICKERS INCORPORATED

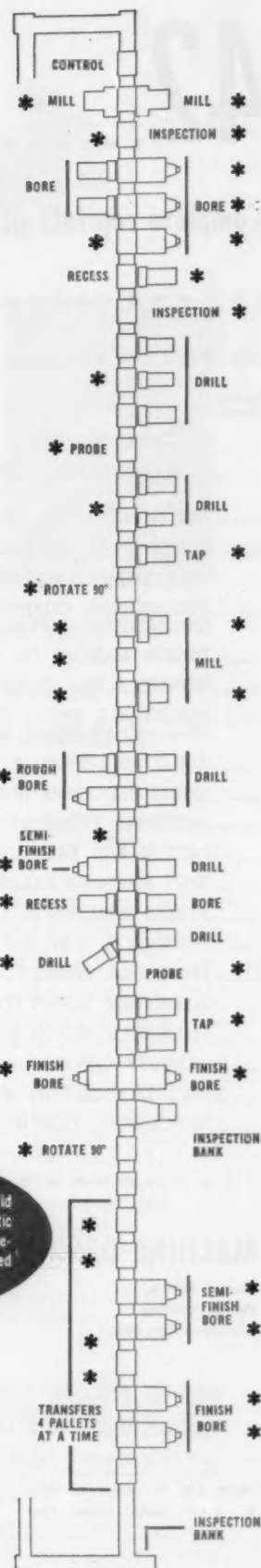
DIVISION OF SPERRY RAND CORPORATION

Machinery Hydraulics Division
 ADMINISTRATIVE and ENGINEERING CENTER
 Department 1430 • Detroit 32, Michigan

8514



Vickers power packages supply fluid energy for fast, precise, automatic clamping, transfer and head movement at station locations marked with asterisk.



Complete reprints of major articles now available from

MACHINE DESIGN

USE THIS FORM TO ORDER YOUR COPIES TODAY!

Number Copies	Price Per Copy	Number Copies	Price Per Copy
— ELECTRIC MOTORS	\$1.00	— TRANSACTIONS OF THE FIRST CONFERENCE ON MECHANISMS	1.00
— ELECTRONIC AND ELECTRIC POWER SUPPLIES	1.00	— TRANSACTIONS OF THE SECOND CONFER- ENCE ON MECHANISMS	1.00
— FRICTION-CLUTCH TRANSMISSIONS	1.00	— TRANSACTIONS OF THE THIRD CONFERENCE ON MECHANISMS	1.00
— HUMAN-FACTORS ENGINEERING	1.00	— TRANSACTIONS OF THE FOURTH CONFER- ENCE ON MECHANISMS	2.00
— DIRECTORY OF MATERIALS—13th Edition	1.00	— TRANSACTIONS OF THE FIFTH CONFERENCE ON MECHANISMS	3.00
— PRODUCTION CHARACTERISTICS OF ENGINEERING METALS	1.00	— MECHANISMS FOR INTERMITTENT MOTION..	1.00
— DESIGN MANUAL ON ADHESIVES	1.00	— POLYDYNE CAM DESIGN	1.00
— NONMETALLIC GASKETS	1.00	— EVALUATING ENGINEERS	1.00
— ADJUSTABLE SPEED DRIVES (Electrical, Mechanical, Hydraulic)	2.00	— ENGINEERING MANAGEMENT	2.00
— ADJUSTABLE-SPEED ELECTRIC-MOTOR DRIVES	1.00	— MEN AND MACHINES	1.00
— SPEED REDUCERS AND GEARMOTORS	1.00	— DESIGNING WITH TEFLON	1.00
— INTERNAL COMBUSTION ENGINES	1.00	— DYNAMIC SEALS AND PACKINGS	1.00
— DESIGN FOR FATIGUE LOADING	1.00	— MECHANICS OF VEHICLES	2.00
— WHY MACHINE PARTS FAIL	1.00	— 1956 DATA SHEETS	2.00
— STRESS ANALYSIS IN DESIGN	1.00	— 1957 DATA SHEETS	2.00
— DIMENSION CONTROL IN DESIGN	1.00	— 1958 DATA SHEETS	2.00
— HYDRAULIC SERVO FUNDAMENTALS Vol. I ...	1.00	— TIPS AND TECHNIQUES—VOL. I (Drafting Aids)	1.00
— HYDRAULIC SERVO FUNDAMENTALS Vol. II ..	1.00	— TIPS AND TECHNIQUES—VOL. II (Engineering Aids)	1.00
— HYDRAULIC SERVO FUNDAMENTALS Vol. III..	1.00	— PLANNING NEW PRODUCTS	3.00
— QUALITY CONTROL METHODS	1.00	— DESIGN GUIDE FLEXIBLE COUPLINGS	1.00
— MULTIPLE CIRCUIT SWITCHES	1.00		
— ELECTRICAL CONNECTORS	1.00		

MACHINE DESIGN

Reader Service
Penton Building
Cleveland 13, Ohio

TOTAL COPIES _____ TOTAL ORDER \$ _____

Remittance or Company Purchase Order must be enclosed with order.

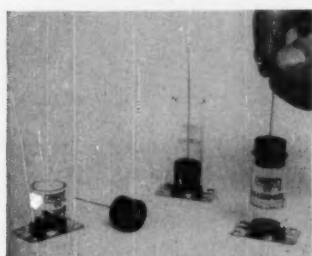
NAME _____ TITLE _____

COMPANY _____

ADDRESS _____

CITY _____ ZONE _____ STATE _____

(Add 3% to orders in Ohio
to cover State Sales Tax)



of recording pens, oscillation damping in rate gyros and other mechanisms. Electric Regulator Corp., Pearl Street, Norwalk, Conn.

Circle 721 on Page 19

Self-Wicking Lubricant

consists of oil and small cellulose fibers

Lifetime-lubricated sleeve bearings, eliminating the conventional oiler hole, can be designed through the use of a self-wicking lubricant, Permawick 265. Pour point of the formulation is -25 F. Lubricant will find application on fractional-horsepower motors, sleeve bearings and pillow blocks in integral-horsepower motors, blowers, pumps, farm equipment, generators, presses, gasoline engines, and lifts. It is also recommended for use with sintered bearings. Material is a combination of oil and minutely particled cellulose fibers which has the feel and appearance of a grease. It is more than 85 per cent fine lubricating oil by weight and occupies hardly any greater volume than the contained oil. It possesses the property of releasing and reabsorbing oil as required to maintain bearing oil film. Permawick is fluid under pressure and completely fills any size or shape of bearing cavity. Oil and wick combination is stable under conditions of extreme moisture, cold, overheating, or oxidizing atmospheres, and is highly resistant to aging. Permawick Co., 5319 E. Outer Drive, Detroit 34, Mich.

Circle 722 on Page 19

Canned Pump

has stainless-steel wetted parts

Low cost, compact canned pump, Dynapump Model 480E, is a seal-less, leakproof unit which weighs



(Above photomicrographs show typical contact cross sections at magnifications of from 100 to 500 times.)

here's helpful selection and use data on **THE CREAM OF OVER 1500 CONTACT GRADES**

Just off press, this 36-page Stackpole Catalog 13-A is a practical guide to composition contact grades, possibilities, properties, uses, shapes, sizes . . . even contact attachment methods.

By molding contacts from two or more metal or carbon-graphite powders, Stackpole Custom Engineering obtains a maximum of the advantages of each material and minimizes its disadvantages. The result is a greater overall efficiency than is generally possible with a single solid metal or alloy. Many of the most desirable contact metals cannot, of course, be alloyed satisfactorily but they can be made from powders in almost any desired proportion.

Composition contact engineering under exclusive Stackpole processes is characterized by its extreme flexibility in obtaining exact needed properties. This is best evidenced by the fact that over 1500 different grades representing different metallurgical mixtures have been produced for specific applications.

In various instances, their advantages permitted increased equipment ratings. In others, they paved the way to smaller, less costly equipment. Often, they simply combined long, trouble free operation with maximum economy.

This Booklet by no means attempts to present composition contacts as a universal answer to all problems. However, for design and production engineers who appreciate the basic logic behind them and who recognize that conventional contact types often leave something to be desired, it will provide a wealth of helpful information and guidance.

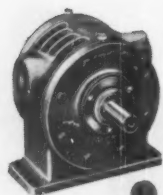
A copy may be obtained on letterhead request (ask for Catalog 13-A) to: STACKPOLE CARBON COMPANY, St. Marys, Pennsylvania.

STACKPOLE

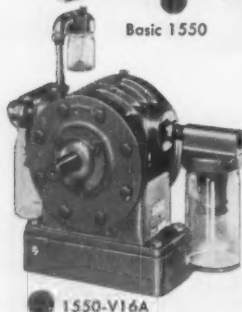
CUSTOM ENGINEERED **CONTACTS**



Also: BRUSHES for all rotating electrical equipment; GRAPHITE CHEMICAL ANODES BEARINGS • SEAL & CLUTCH RINGS • VOLTAGE REGULATOR DISCS • FRICTION SEGMENTS CERAMIC MAGNETS . . . and many other carbon, graphite and metal powder products.

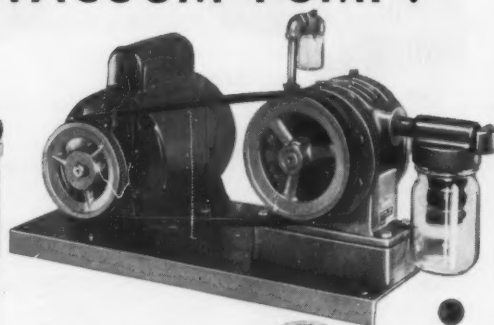


Basic 1550



1550-V16A

Need an original equipment VACUUM PUMP?



1550-V4D-G34

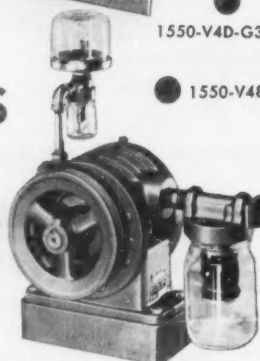
SEE HOW GAST CUTS YOUR COSTS

These pictures demonstrate how *your* product—and cost budget—may benefit when you select Gast rotary Vacuum Pumps for original equipment.

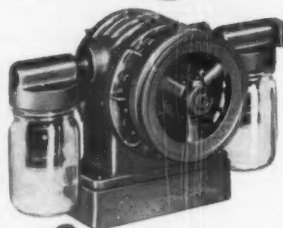
Above (1) is a basic Model 1550 less accessories (one of 13 sizes). For current, active customers, Gast builds this model in dozens of variations. Each one meets specific needs for vacuum, pressure, lubrication, drive method and type of service.

For example, (2) is equipped with wick oiler, and intake and outlet filters for both vacuum and pressure used on paper feeding applications. (3) includes fan-pulley, belt, motor and base as sold for intermittent operation on vacuum-back cameras, vacuum chucks and plastic sheet forming units. (4) has new, large constant-level oiler for rigorous industrial duty. (5) *never* needs oil—has carbon vanes for oil-free air. (6) is a 1550 Model Air Compressor with air intake filter.

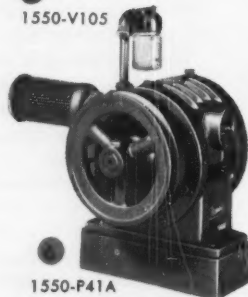
As you see, each original equipment buyer gets a job engineered pump. *In the same way, you can save money, because Gast ingenuity—and tooling and manufacturing efficiency—permit precision quality at production prices.*



1550-V48



1550-V105



1550-P41A
Air Compressor

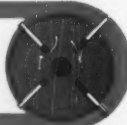
WRITE FOR FULL DETAILS—REQUEST CATALOG

GAST MANUFACTURING CORP., P.O. Box 117-P Benton Harbor, Michigan
SEE CATALOG IN SWEET'S PRODUCT DESIGN FILE OR FLUID POWER DIRECTORY

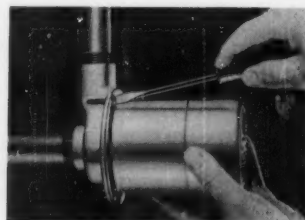
GAST

- AIR MOTORS TO 7 H.P.
- COMPRESSORS TO 30 P.S.I.
- VACUUM PUMPS TO 28 IN.

"Air may be your answer!"



NEW PARTS AND MATERIALS



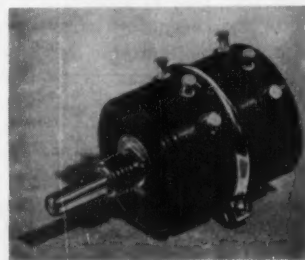
less than 7 lb, yet handles capacities to 840 gph. Equipped with stainless-steel wetted parts, it produces heads up to 9 ft. Unit is suitable for temperatures to 220 F, pressures to 150 psi, and specific gravities to 1.5. Fluids must be free of abrasives or other foreign materials. Standard pump is furnished with a Class-H insulated, 115-v, 50 or 60-cycle, single-phase motor with built-in overload protection. **Chempump Div., Fostoria Corp., Dept. 59, Buck & County Line Roads, Huntingdon Valley, Pa.**

Circle 723 on Page 19

Trimmer Potentiometers

in 8 standard resistances
from 100 to 25,000 ohms

Six new miniature trimmer potentiometers with $\frac{1}{8}$ -in. diam are available in eight standard resistance values from 100 to 25,000 ohms. All values are manufactured with 20 ppm resistance wire and dissipate 1 w at 125 C for a period of at least



2000 hours. Ambient temperature range is -65 to 150 C. All models of the Type 118 meet environmental requirements of MIL-STD-202A and NAS710. **Carter Mfg. Corp., 23 Washington St., Hudson, Mass.**

Circle 724 on Page 19

Subminiature Switch

is three-circuit,
pushbutton type

Weighing only 3.5 grams, new three-



RIVNUTS® streamline tank design; eliminate damage to product

This oil reservoir, fabricated by Stolper Steel Corporation, Menomonee Falls, Wisconsin, for a husky new Allis-Chalmers tractor-shovel, requires removable cover plates. This is accomplished with flush-mounted RIVNUTS and threaded bolts.

With RIVNUTS, all possible damage is eliminated, since the RIVNUTS project inside the tank. Installation is simple: holes drilled and countersunk, RIVNUTS upset with a heading tool. Flush installation permits obtaining a liquid-tight joint without grinding.

RIVNUTS are the only one-piece blind rivets with internal threads. If you'd like recommendations on a specific fastening problem, please send a print of your part. For descriptive bulletin, see Sweet's Product Design File, or write *Dept. MD-6, B. F. Goodrich Aviation Products, a division of The B. F. Goodrich Company, Akron, Ohio.*



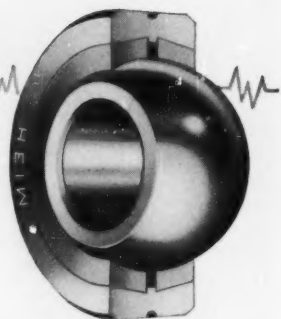
B.F. Goodrich Rivnuts

To Eliminate Vibration

in Missile Trays Stored in
Naval Vessel Missile Magazines.



Hydraulic damping devices are necessary to dampen vibration experienced in shipboard stowage of the TALOS missile trays. The Buffalo Hydraulics Division of Houdaille Industries, Inc. designed and built this Missile Tray Damper to physically isolate the missile itself from the vibrations that could be experienced during stowage.

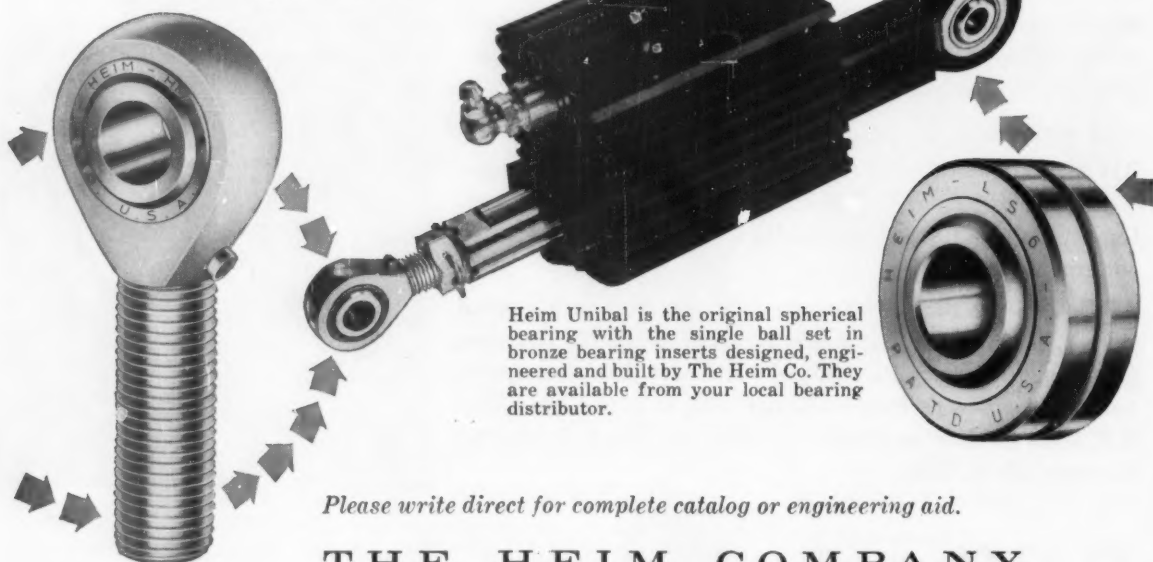


With the misalignment which can be expected of equipment used on shipboard it was necessary to use a reliable, inexpensive self-aligning rod end such as

HEIM Unibal[®] SPHERICAL BEARING

At one end of the damper is a male threaded HMX-6FG Heim rod end with a flush-type lubricating fitting; and opposing this, a Heim LS-6 Unibal spherical bearing is locked into the damper housing.

The unit which uses MIL-F-17111 Fluid has an adjustable damping range from 30 to 600 lb/in/sec, and is designed for continuous operation at $\pm .1$ inch at 7 cps or normal operation of $\pm .031$ inches at 5-15 cps and $\pm .015$ inches up to 25 cps. The design life is 50,000 hours.



Heim Unibal is the original spherical bearing with the single ball set in bronze bearing inserts designed, engineered and built by The Heim Co. They are available from your local bearing distributor.

Please write direct for complete catalog or engineering aid.

THE HEIM COMPANY
FAIRFIELD, CONNECTICUT



pole, single-throw, momentary-type switch is specifically designed for long, reliable life in rugged-duty applications, and is also suitable for use in computers and telephone switchboards. Color-key nylon caps for pushbutton plunger are easily snapped on or off and are available in white, black, blue, brown, green, orange, red, and yellow. Contact rating is 2 amp resistive or 1 amp inductive at 29 v dc or 115 v ac. Unit has high shock and vibration resistance. Allied Control Co. Inc., 2 East End Ave., New York 21, N. Y.

Circle 725 on Page 19

Porous-Anode Capacitor

tiny tantalum unit provides high capacitance retention

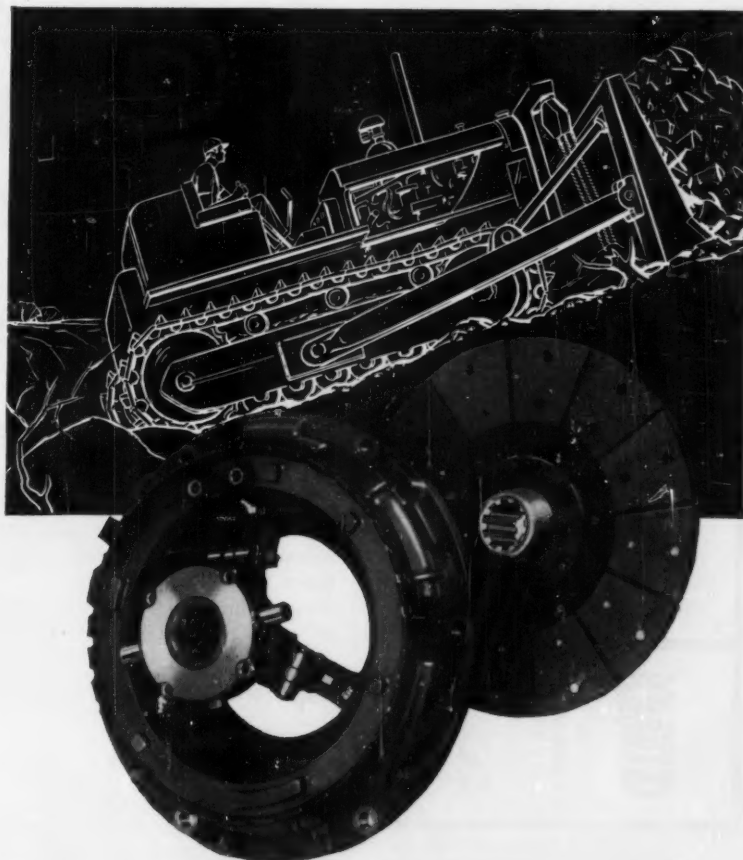
Miniature porous-anode Tantalytic capacitor, measuring only 0.075 x 0.250 in. over the insulation sleeving, provides high capacitance retention. Rated at 50 v, 1 mf, capacitor retains 85 per cent of its room temperature capacitance at -55 C. Unit performs at 15 g, 2000 cps. Nominal impedance at -55 C is 1600 ohms. Specialty Electric Capacitor Section, General Electric Co., P. O. Box 158, Irmo, S. C.

Circle 726 on Page 19

Motor-Driven Pump

for use with all clear liquids

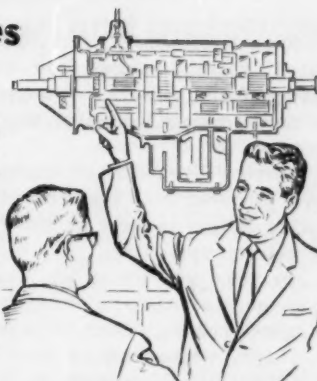
Positive-displacement, motor-driven pump is adaptable to a broad range of applications, particularly precise pumping, measuring, and lubricating. Pump moves as little as one drop of liquid every 5 min or as much as 1 pint per minute. Simple, positive adjustment is provided for metering exact quantities. Standard



BETTER COMPONENTS... BETTER PRODUCTS!

Cooperation produces the final design

When each component part is the best, the whole machine is right. Rockford Over-Center Clutches are the finest made for crawlers, cranes and other heavy-duty equipment. If your equipment is in the design stage, let Rockford Clutch engineers help you select the best clutch. Rockford Clutches in standard sizes suit almost every need. Custom models can be designed for your applications. Call or write for the Rockford Clutch Catalog.



ROCKFORD CLUTCHES

ROCKFORD CLUTCH DIVISION

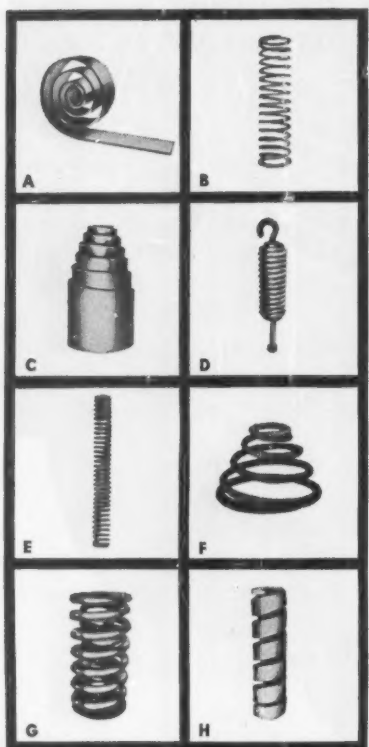
BORG-WARNER



311 CATHERINE ST.
ROCKFORD, ILLINOIS

Export Sales
Borg-Warner International
36 So. Wabash, Chicago, Ill.

Can you identify
these springs?



A. flat B. helical C. volute D. extension
E. helical F. cone G. helical, triple-coil
H. rectangular section

Over One Million ALCO SPRING DESIGNS

ALCO's complete line of "performance-rated" springs ranges from small springs for light work to heavy-duty triple-coil springs for heavy, sustained work.

In over 80 years, ALCO engineers have produced more than one million spring designs to serve almost every conceivable application.

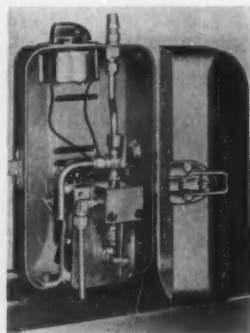
For your next spring job, contact your nearest ALCO sales office. To obtain brochure, *ALCO Springs for Industry*, write to ALCO Products, Inc., Dept. 160, Schenectady, N. Y.



ALCO PRODUCTS, INC.
NEW YORK
SALES OFFICES IN PRINCIPAL CITIES

Circle 537 on Page 19

NEW PARTS AND MATERIALS



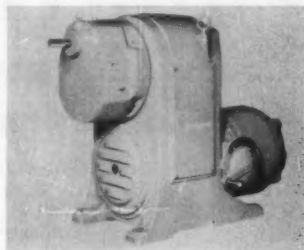
110 or 220-v model is made of metal, is noncorrosive to ordinary liquids with stronger than usual corrosive qualities. Pump operates under a variety of heads or pressures. Pump Div., Bomar Laboratories Ltd., Sheridan Road at Winton, Chicago 41, Ill.

Circle 727 on Page 19

Adjustable-Speed Drive

provides speeds from
2500 to 25,000 rpm

Type VEU-GHY Varidrive is available for sustained operation at speeds from 2500 to 25,000 rpm. Unit is available on special order with up to 5 hp, drip-proof, totally enclosed, or explosionproof motors. Varidrive combines standard high-speed electric motor and adjustable-speed transmission with new gear



increaser. Entire unit, which stands less than 2 ft high, eliminates external gear boxes, belts, or pulleys. U. S. Electrical Motors Inc., Box 2058, Terminal Annex, Los Angeles 54, Calif.

Circle 728 on Page 19

Electrical Interlock

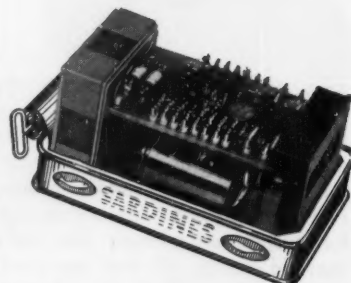
for mounting on dc
magnetic contactors

Type L-63 electrical interlock is capable of closing and carrying 10



SPECTROL PRECISION MECHANISMS

The Big Squeeze Job



SPECTROL's new PRECISION MECHANISM—a velocity servo—is more than just another interesting shrink job. It's useful. It can go anywhere you need an ultra-miniature, precision speed control device.

First, the package. It measures only 1½ x 1½ x 3 inches. In a space that would give a sardine claustrophobia, Spectrol engineers squeezed a solid-state amplifier, a servo-motor, a gear train, and a very special, condensed (½-inch long) potentiometer and switch.

The pot has four electrically isolated wipers, all riding 90° apart on the same coil. The switch, in the same pot housing, has four wipers riding on an alternately conducting and non-conducting surface.

THE FUNCTION: The servo accepts dc signals varying between ±10 v from a computer to drive the pot in such a manner that speed is directly proportional to the dc signals.

THE APPLICATIONS: Here's an example: tied to an airborne computer, the Spectrol servo will drive a scope in the cockpit of one of the nation's hottest aircraft. The object: to give the pilot a visual, three-dimensional analog of his position. Actually, the servo will drive anything—resolvers, synchros, tachs, other pots and switches. It's a complete, ready-to-go package you can put into your system as is.

This is another example of how Spectrol PRECISION MECHANISMS free the systems engineer from building functional sub-assemblies using components such as gear drives, clutches, precision potentiometers and servomotors. If you need modules combining any of these components in a single specification—Spectrol can help.

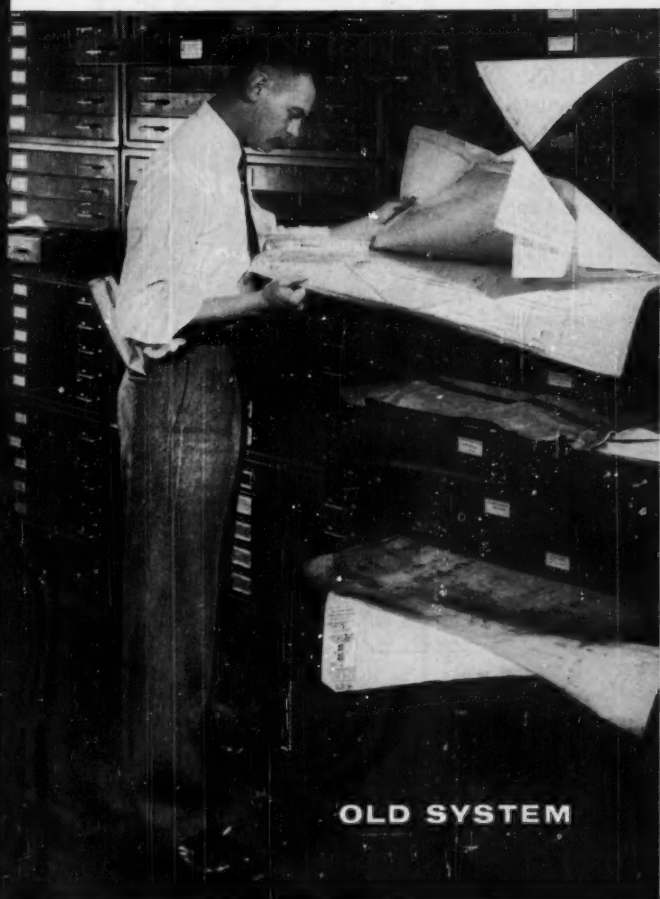
For more details, call your Spectrol engineering sales representative, or address Dept. 63.



ELECTRONICS CORPORATION
1704 SOUTH DEL MAR AVE. • SAN GABRIEL, CALIF.

Circle 538 on Page 19

thanks to *automatic xerography*...



OLD SYSTEM



NEW SYSTEM

REDUCE DRAWING-STORAGE SPACE UP TO 95% Save \$20,000 to \$100,000 yearly on time, labor, and materials!

How would you like to reduce—by as much as 95%—the storage space you now allot to active and inactive engineering drawings?

In so doing, you'll also reduce time and labor costs dramatically. Savings as high as \$100,000 a year can be achieved because of a spectacular breakthrough in storage and reproduction techniques.

This development, called a unitized microfilm system, has three basic steps: micro-filming origi-

nal drawings or changes; mounting individual frames into diecut apertures of data-processing cards; and, from the cards, automatically enlarging the microfilmed drawings by xerography, fast and economically, in a Xerox® Copyflo® 24C continuous printer.

Dry, positive prints, translucent intermediates, or offset paper masters emerge at the rate of 20 feet a minute. They are automatically cut, and ready for immediate use.

The aperture cards, which may be machine-sorted for any combination, are stored in miniature working files, occupying only a tiny fraction of the space required by blueprints, intermediates, or originals.

There is no refiling. The quality of xerographic prints is superbly high, yet they are so inexpensive that engineers are urged to discard them after use.

Unitized microfilm systems offer many other striking economies in time, money, and materials. Our booklet X-300, showing the many benefits, is yours for the asking. Write HALOID XEROX Inc., 60-113X Haloid St., Rochester 3, New York. Branch offices in principal U. S. and Canadian cities.

Overseas: Rank-Xerox Ltd., London.



PUSH THE BUTTON...AND COPIES FLOW!

HALOID XEROX®

**Savings
like this
deserve
a closer
look*



COLD HEADING SAVES OVER 300%

ON THIS TERMINAL POST

Due to the many technical problems involved, only Hubbell was willing to tackle this job. The result: big savings in production costs, greater uniformity, and faster delivery. This is just one more example of Hubbell's ability to solve tough and unusual cold heading problems.

Original Screw Machined Part	Same Part Re-designed for Hubbell Cold Heading
	HEAD INDENTED to fill out sides, make corners sharp
	MINIMUM FILLET under head to permit close seating
	SHANK EXTRUDED due to equal dia. of shank and thread
	CLOSE TOLERANCE MAINTAINED on length and diameter
	CRITICAL FIT . . . to class #2 specifications

*A closer look at your fastener requirements may reveal some that lend themselves to the economies of Hubbell cold heading. If so, investigate! Send us samples or blueprints of the parts for analysis and estimate. No obligation.

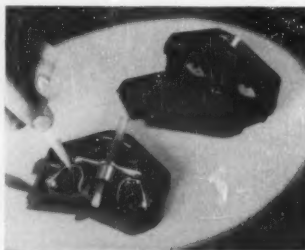
**HARVEY
HUBBELL
INCORPORATED**

Machine Screw Department Bridgeport 2, Connecticut

Circle 540 on Page 19

NEW PARTS AND MATERIALS

amp continuously. It has a dc interrupting capacity of 300 va inductive at a maximum of 600 v. Unit is designed primarily for mounting on dc magnetic contactors. Single unit provides one contact either normally open or closed. This is achieved by selection of one of two positions for the contact spring seat. Access to spring seat is obtained easily by removing either one of two sealing caps. Operation of the



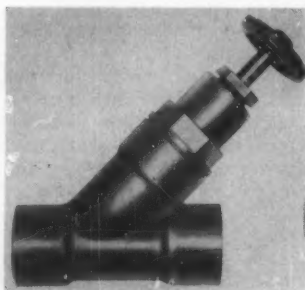
interlock is independent of terminal polarity. Very little maintenance is required beyond occasional examination to see that parts move freely without friction or binding. Westinghouse Electric Corp., P. O. Box 2099, Pittsburgh 30, Pa.

Circle 729 on Page 19

PVC Globe Valves

for 125-psi service
at 145 F

New line of PVC globe valves is furnished in a complete size range from 1/2 through 3 in. with either screwed or socket-weld ends, and is rated for 125 psi service at 145 F. Valves are completely molded of a nonplasticized polyvinyl-chloride resin, resulting in maximum chemical resistance and strength. They are designed for use in piping systems handling acids, alkalis, chemical salt solutions, pharmaceuticals, and distilled water, as well as beverages and food products. In addition to



**Servospeed
HEART OF
AUTOMATION**

**MODERN
ELECTRONIC
ENGINEERING
GIVES PRECISE
MOTOR SPEED
CONTROL
1/100 — 10 H. P.**

Modern industrial electronic engineering has been coordinated with electric motor design to provide a versatile means for obtaining the full possible advantage of speed control in DC motors while operated from the regular alternating current power line. Grid controlled "Thyratron" tubes are utilized for power controlled stepless variation to supply motor armature power. Patented feedback, or "Servo" circuits provide constant torque capability over wide speed ranges of as high as 60 to 1 in some models and a minimum of 20 to 1 in others.

Servospeed
DIV. of ELECTRO DEVICES Inc.
4 Godwin Ave., Paterson, N. J.
ARMory 4-8989

Circle 541 on Page 19



Wind Velocities to Mach 7 Prove Needle-Size Superior Stainless Tubing

Manometer lines of Superior Type 304 stainless tubing, drawn to needle size, withstand the vibration caused by air speeds beyond Mach 7 and internal pressures as high as 5000 psi in FluiDyne wind-tunnel tests of missile component models. And they have been in some assemblies for $3\frac{1}{2}$ years without cracking, pinholing or buckling.

FluiDyne Engineering Corp., one of the major designers of such test facilities, attributes the long life of this Superior tubing to both its high modulus of elasticity and its resistance to the corrosive effects of mercury and soldering-flux acid.

Ductility is a big advantage, too. This permits the Superior tubing to be easily hand-bent into complex shapes for application in wind tunnels and readout equipment.

Filling stainless steel tubing orders that call for tiny needle tubing in gages from 6 to 33 or tubing with OD's as large as 1.125 in. calls for the resources Superior has to offer. Why not investigate us as a source of small-diameter stainless tubing. Catalog 21 describes the types and analyses available. Also gives tips on its selection and application. Superior Tube Company, 2010 Germantown Ave., Norristown, Pa.

Superior Tube

The big name in small tubing
NORRISTOWN, PA.

All analyses .010 in. to $\frac{5}{8}$ in. OD—certain analyses in light walls up to $2\frac{1}{2}$ in. OD

West Coast: Pacific Tube Company, Los Angeles, California • FIRST STEEL TUBE MILL IN THE WEST

At last!

**A
STEP-BY-STEP
GUIDE TO ...**



This 102 page volume
includes practical data on:

- ▶ Measuring company needs
in new-product development
- ▶ Developing and finding new-product ideas
- ▶ Evaluating new-product potentials
- ▶ Organizing engineering and research for product development
- ▶ Measuring progress in product performance

MACHINE DESIGN

Reader Service, Penton Building Cleveland 13, Ohio

(Remittance or Company Purchase Order must be enclosed with order.)

Send me _____ copies of
Planning New Products @ \$3.00 each

NAME _____

COMPANY _____

ADDRESS _____

CITY _____ ZONE _____ STATE _____

(Add 3% to orders for delivery in Ohio to cover State Sales Tax.)

This collection of 17 helpful articles details the necessary steps to the development and engineering of new products. Written by Dr. Philip Marvin, well-known market consultant, this book is "required reading" for *every* engineer responsible for the development of new product ideas or the operation of a research program.

A

MACHINE DESIGN

REPRINT

← **MAIL TODAY** _____

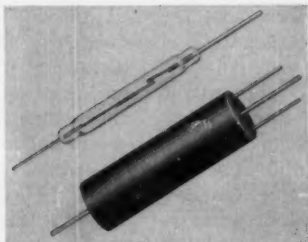
chemical inertness, there is no odor, flavor, or taste imparted to the handled product. Valves have high strength-to-weight ratio. **Dorak Products Corp.**, 78 Pearl St., New York 4, N. Y.

Circle 730 on Page 19

Reed Relays

provide high
operating speeds

Dunco reed relays provide dependability and performance for computers, data-processing equipment, transistor drives, and other applications. Hermetically sealed, glass-encapsulated magnetic reed switch is surrounded by an operating coil to provide SPST, normally open relay action. Units are well suited for



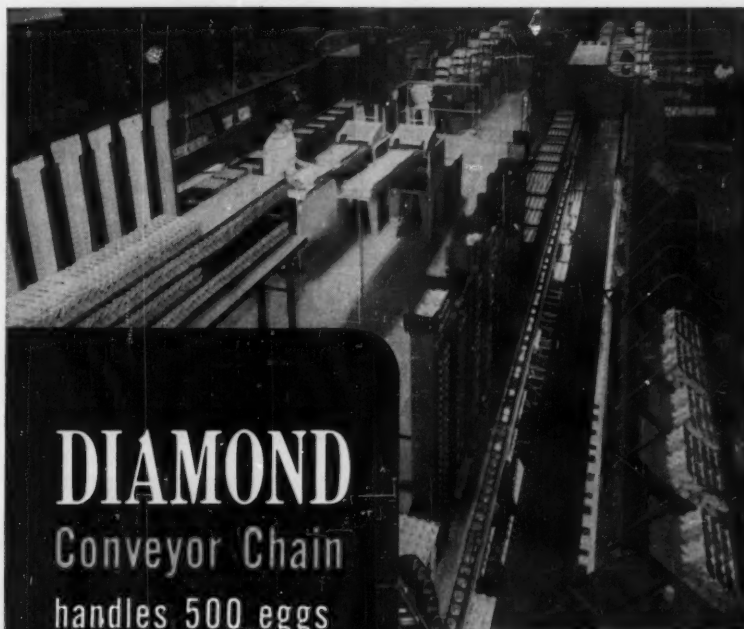
low-level switching or for low-power switching of loads up to 15 w and 250 v. Maximum operating current is 1 amp. Minimum operating power is approximately 100 mw. Single contact relay with coil as illustrated is approximately 9/16 in. in diam and 3 1/4 in. long. **Struthers-Dunn Inc.**, Pitman, N. J.

Circle 731 on Page 19

Tandem Cylinders

provide hydraulic control
to air-operated cylinder

Model BT tandem cylinders consist of two cylinders in line, featuring a common head at the center and two separate pistons mounted on one solid rod. Cylinders are available in bore sizes of 1 1/2, 2, 2 1/2, 3, and 4 in. in lengths to 80 in., and a choice of mounts is offered. Rods are stainless steel, and steel or brass tubes are treated for corrosion. Units provide the advantages of hydraulic control to an air-operated cylinder. Hydraulic fluid can be used either in the front cylinder or in the center section of the unit without a



DIAMOND
Conveyor Chain
handles 500 eggs
per minute in
fmc Automatic
Egg Handling
System

FMC System utilizes electronic "brain" to weigh, record, code, count, treat, pack and date 30,000 eggs per hour.

Actual egg handling is accomplished by **DIAMOND** Conveyor Chain equipped with special attachments and nylon egg cups.

◆ With split-second precision, **DIAMOND** Conveyor Chain receives, moves, positions 240,000 eggs during each eight hour shift. It's a high-speed operation where a momentary foul-up could cause a king-sized omelette; where synchronization, timing and dependable, trouble-free service are absolutely essential. That's why Food Machinery and Chemical Corporation specifies **DIAMOND** Conveyor Chain for its electronically controlled Automatic Egg Handling System.

DIAMOND CHAIN COMPANY, INC.

A Subsidiary of American Steel Foundries

Dept. 435, 402 Kentucky Avenue • Indianapolis 7, Indiana

DIAMOND



**ROLLER
CHAINS**

- Offices and
- Distributors in all
- Principal Cities

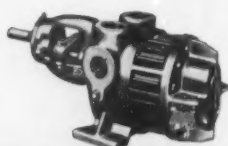
WHATEVER YOUR REQUIREMENTS FOR ROTARY PUMPS, THERE'S A ROPER TO DO THE JOB

Series T .3 to 55 GPM Choice of 192 Models

Pump and motor units . . . pump serves as end bell of motor. Require minimum space . . . easily installed . . . no coupling required . . . mount in any position. Each unit approximately same size as NEMA motor of HP required for driving. Open drip proof or totally enclosed motors; single or three phase as required.



ROPER ROTARY PUMPS



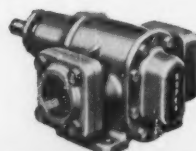
Series F 1 to 300 GPM Pressures to 300 PSI

Feature helical steel pumping gears, hardened steel shafts, bronze flange-type bearings. 4-port design with 8 optional piping arrangements (4 for CW and 4 for CCW rotation) solves installation problems. With or without built-in relief valve in either mechanical seal or packed box construction.

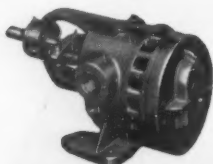
ROPER ROTARY PUMPS

Series K 3/4 to 50 GPM Pressures to 150 PSI

Extremely compact in all sizes. Helical pumping gears are hardened steel, with steel shafts and bronze bearings. Sizes 10 through 50 GPM have patented venturi suction and discharge principle for smooth flow and quiet operation. With or without built-in relief valve; packed box or mechanical seal.



ROPER ROTARY PUMPS



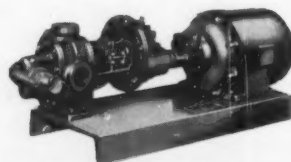
Series H 5 to 75 GPM Pressures to 1000 PSI

Designed to operate at direct motor speeds. Used for all types of hydraulic mechanisms where high pressures are required. Hardened steel spur gears for maximum efficiency, and heavy duty roller bearings and bronze wear plates for long life service. Mechanical seal or packed box.

ROPER ROTARY PUMPS

Series 3600 40 to 300 GPM Pressures to 100 PSI

Handle thick or thin liquids at slow speeds. Operate in either direction. Hardened iron pumping gears, hardened steel shafts, heavy duty bronze sleeve bearings. Mechanical seal or packed box. Series includes tank truck pumps as well as single motor driven units with gear reduction.



ROPER ROTARY PUMPS

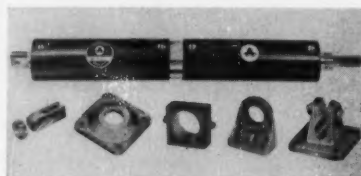
Send for
"How to Solve Pumping Problems"

Roper Hydraulics, Inc.

Manufacturers of Standard, Special and Custom Pumps for All Industries

COMMERCE,
GEORGIA

NEW PARTS AND MATERIALS



make-up chamber. Full speed control is obtained by piping flow-control valves in series with the two ports used for the hydraulic section. Allenair Corp., 255 E. 2nd St., Minneola, N. Y.

Circle 732 on Page 19

Power Resistor

subminiature unit has
precision tolerance

RH-5 wire-wound resistor is sealed in silicone and enclosed in an aluminum radiator-finned housing for mounting to a chassis or heat sink for maximum heat dissipation. It is for applications requiring a power resistor with precision tolerance. Unit operates under severe environmental conditions and meets applicable paragraphs of MIL-R-18546B (ships). Impervious to moisture and salt spray, it features welded construction from terminal to terminal. Rated at 5 w up to 100 C when mounted on a 5 x 7 x 0.026-in. panel, it has a free-air rating of 5 w at 25 C. Operating temperature range is -55 to +275C with a temperature coefficient of 0.00002 in. per deg C. Resistance range is 10 to 20,000 ohms with tolerances of 0.05, 0.1, 0.25, 0.5, 1, and 3 per cent. Dale Products Inc., Columbus, Neb.

Circle 733 on Page 19

Trimmer Potentiometer

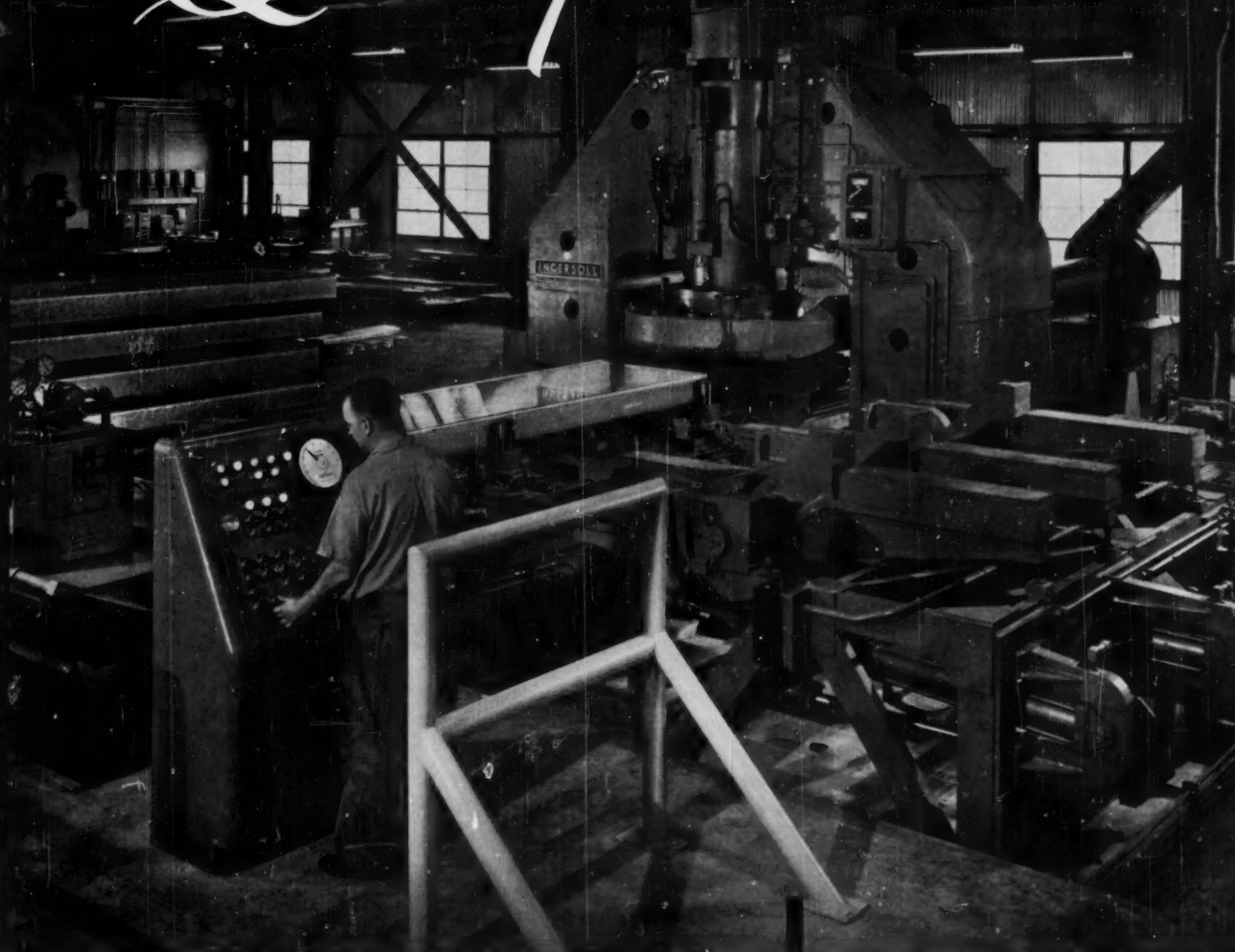
subminiature unit is for
general-purpose applications

W-51 subminiature trimmer potentiometer has a standard range of resistances from 10 through 100,000 ohms, with tolerance to ± 10 per



MODERN EQUIPMENT PRODUCES

Quality Aluminum



This new INGERSOLL scalping machine is another important step in QSM's production of quality aluminum sheet and coil. Taking the aluminum ingot directly from our cast house, it removes oxides and roughnesses which may have been built up on the surface. It assures a clear, smooth ingot ready for the rolling mill. The first horizontal scalper in the country, it embodies many new design features to aid QSM in producing aluminum sheet and coil of the finest quality.



QUAKER STATE METALS CO. • LANCASTER, PA.

Division of HOWE SOUND COMPANY

Mill Producers of Aluminum Sheet and Coil

Phone Chicago DEarborn 2-2524 • Milwaukee HOpkins 3-1444

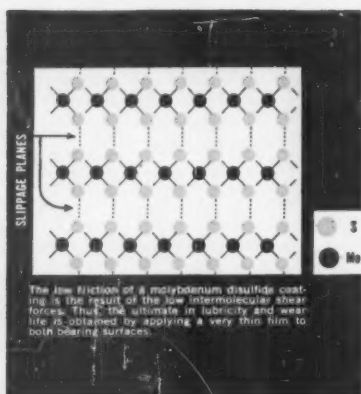
Circle 546 on Page 19





FORMULA FOR TOMORROW'S LUBRICANT

One-time lubrication . . . permanent, dry lubrication . . . applied with the greatest of ease to virtually any type of material—that's just a small part of the amazing story of what Poxylube can do for you.



Poxylube replaces conventional greases and oils, does away forever with the need for lubrication, and can be bonded permanently to structural metals, metal products, wood, plastics and glass. Poxylube can be applied by spraying, dipping or brushing, with

no surface pre-treatment except degreasing.

Poxylube performs! It supports pressures up to 90,000 psi, operates in temperatures between -100° F. and +500° F., and has a coefficient of friction range of from .025 to .065. It's effective in thicknesses between .0001 and .0004 inch.

How does Poxylube do it? The molybdenum disulfide pigment making up most of the Poxylube film consists of a multitude of flat laminar platelets—40 molecular layers to a millionth of an inch—of alternating molybdenum and sulfur atoms. These layers permit approximately 39 slip-plane planes to a millionth of an inch . . . thus achieving high film strength and adhesion.

Whether you're lubricating egg-beaters or engines, hinges or helicopters, Poxylube can help you do the job better, permanently, and at less overall cost. Poxylube is currently being used in major missile and space projects. Write for information today.

*Pioneering in
Industrial Dry Lubricants*

POXY LUBE

POLY CHEM • 541 South Webster Avenue, Indianapolis 19, Indiana

NEW PARTS AND MATERIALS

cent. Unit with 0.750-in. mounting-hole center is available with 12-in. flexible insulated wire leads, solder lugs, or end-mounted, printed-circuit pins. **Atohm Electronics**, 7648 San Fernando Rd., Sun Valley, Calif.

Circle 734 on Page 19

Explosive-Actuated Valve

is insensitive to
back pressure

Model 1014-2 normally-closed, explosive-actuated valve is suitable for operation with liquids or gases. It contains a balanced piston and is insensitive to back pressure. Valve is rated at 4200 psi. Temperature range is -65 to +160 F, but valve may be exposed to short-term temperatures up to 300 F. Valve is designed



for manifold mounting and is a zero-leak unit. Flow passage is 5/32 in., and weight is 2.6 oz. **Pyronetics**, 11973 E. Slauson, Santa Fe Springs, Calif.

Circle 735 on Page 19

Wire-Wound Resistors

are available in
two new ratings

Molded wire-wound resistors are single-layer-wound on ceramic cores. Jacket of silicone-ceramic material is pressure molded over the core to provide a uniformly thick cover of high insulating and moisture-resistant properties. Two new ratings available are 1 and 7 w. Two physical sizes are provided in the 1-w rating. Size A is 0.417 in. long x 0.150 in. diam with a range to 4500 ohms; size B is 0.542 in. long x 0.150 in. diam with a range to 6500 ohms. The 7-w size measures 1.218 in. long x 0.323 in. diam with a range to 30,000 ohms. Rated at 25 C, the units can be used in much higher ambients at considerable



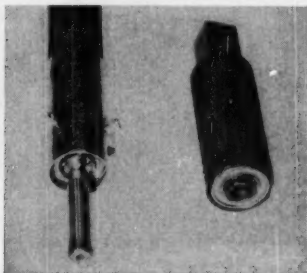
wattages, since they derate linearly to 0 w at 275 C. Ohmite Mfg. Co., 3642 Howard St., Skokie, Ill.

Circle 736 on Page 19

Flexible Shafts

for heavy-duty power drives

Splined power-drive flexible shafts transmit rotary power over any curved path. They have many applications in manufacturing plants, and provide power take-off auxiliary drives on trucks and tractor trailers. Shaft has a 1-in. diam core capable of power transmission to 760 lb-in. of torque at 600 rpm. Shaft is equipped with a splined slip coupling at one end which slides back and forth under load to take care of slight changes in length caused by varying load conditions. Couplings of various bores are available for connecting at each end. Steel-backed bronze sleeve bearings



support core at each end of shaft. Shaft is available cut to any required length. Stow Mfg. Co., 11 Shear St., Binghamton, N. Y.


Circle 737 on Page 19

Terminal Boards





for resistor mounting

Three Cambion eight-lug terminal boards for resistor mounting are 1/16-in. thick glass fiber, impregnated with melamine resin. Three sizes are available: Board 1450 is

ELECTRONIC MOLDING...



symbol of production efficiency







Precision in timing, temperature, and tool design, is a necessity in molding a perfect rubber product. At PARCO, the efficiency of the Parco-Matic process is greatly expedited by the use of ingeniously designed electronic controls for both timing and temperature, permitting greater useage of the exacting molding dies designed by experienced PARCO tooling engineers.

Parco-Matic operators' experience is another distinct asset in exacting rubber molding. PARCO scientific operators are trained to regard strict die cleanliness, die register, and die handling to assure the ultimate in exacting rubber parts. All contribute to product perfection in this electronic era.

This is why, at PARCO, electronic molding is a symbol of production efficiency!

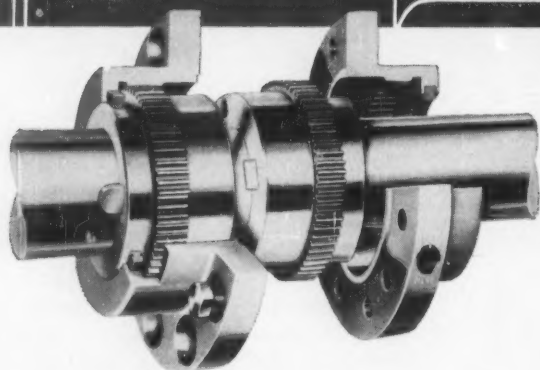
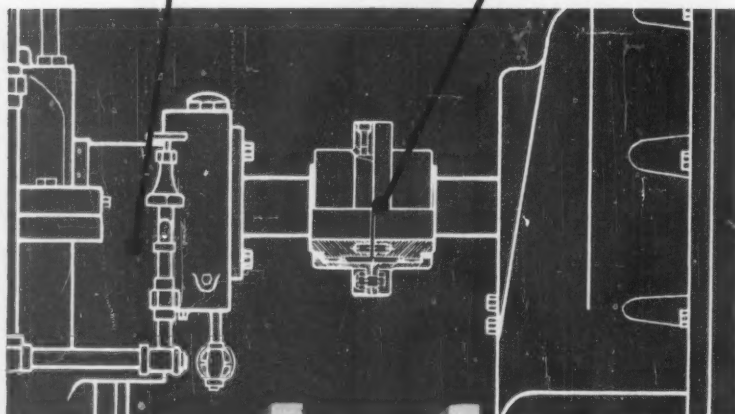
Send today for your free PARCO Pic-O-Ring desk/wall chart. A must when "O" Rings are concerned.



PLASTIC AND RUBBER PRODUCTS COMPANY
2100 Hyde Park Boulevard • Los Angeles 47, California

FOR
"AS DESIGNED"
PERFORMANCE
HERE

SPECIFY
WALDRON
COUPLINGS
HERE



When a lot of time and effort have been put into the design of a driven unit, it makes sense to protect its operating efficiency with a good coupling.

Waldron gear couplings are available in a wide range of standard and special types for any service requirement, to provide complete protection and positive, trouble-free drive.

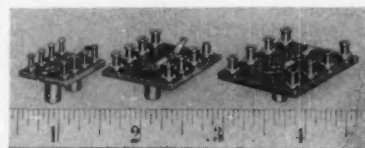
Deliveries are excellent. Rough bore standard couplings up to 6" sizes, already assembled, can be shipped from stock; others, to meet customers' schedules.



WALDRON-HARTIG DIVISION Midland-Ross Corporation
P. O. Box 791 • New Brunswick, New Jersey

Circle 549 on Page 19

NEW PARTS AND MATERIALS



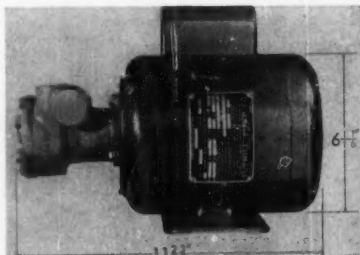
$\frac{7}{8}$ x $\frac{23}{32}$ in. with terminal rows $\frac{1}{2}$ in. apart; No. 1451 is $1-\frac{7}{32}$ x $1-\frac{1}{32}$ in. with terminal rows $\frac{3}{4}$ in. apart; No. 1452 is $1\frac{1}{2}$ x $1-\frac{5}{32}$ in. with terminal rows $\frac{7}{8}$ in. apart. Terminals extend $\frac{3}{16}$ in. above boards. Each board has rounding strap swaged to mounting studs for positive RF grounding. All metal parts are brass per QQ-B-626 $\frac{1}{2}$ hard. **Cambridge Thermionic Corp.**, 445 Concord Ave., Cambridge 38, Mass.

Circle 738 on Page 19

Pump-Motor

has dimensions of
6-11/16 x 11-23/32 in.

Series 56 pump and motor combination is available for use in hydraulic, lubrication, oil burning, fuel transfer, and other services. Combination includes motors in NEMA 56 series ranging from $\frac{1}{4}$ to 1 hp in either single or three phase. They can be combined with five different pumps with capacities from 20 to 360 gph, at 200



psi. Series has over-all dimensions of 6-11/16 x 11-23/32 in. **Tuthill Pump Co.**, 939 E. 95th St., Chicago, Ill.

Circle 739 on Page 19

Switch Assembly

for pulse and digital
electronic systems

One-shot switch-circuit pushbutton assemblies are designed for pulse and digital electronic systems. Assemblies generate a single square-wave pulse synchronized with a

FASTENERING

TIPS ON FASTENER APPLICATIONS BY STANSCREW

Bright or Heat-Treated Hex Cap Screws? Each can save you money

Bright and heat-treated hex cap screws (SAE Grade 5) are produced to the same dimensional specifications. Heat-treating, which results in a somewhat higher cost, gives superior hardness. The greatest difference is the higher tensile strength, as shown below.

HOW TENSILE STRENGTH COMPARES

Diameter Coarse Thread (UNC)	Bright Cap Screws Tensile Strength (Pounds)	Heat-Treated Cap Screws Tensile Strength (Pounds)
1/4"	2,200	3,800
5/16"	3,600	6,300
3/8"	5,350	9,300
1/2"	9,800	17,050
5/8"	14,450	27,100
3/4"	21,400	40,100

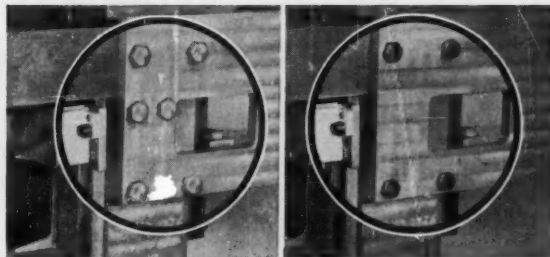
Pick The Right One

Selecting the right cap screw can mean substantial savings. For example, in the support plate assembly at right, six 3/8" bright cap screws were used. Investigation showed four 5/16" heat-treated cap screws could do the job more efficiently. By eliminating two fasteners and substituting a smaller size, total fastener costs were cut 37% . . . and important additional savings were made by reducing machining and assembly time.

The best answer for any application can be determined only after careful consideration of the advantages and disadvantages of both fasteners.

Bright Hex Cap Screw Advantages

1. In pure fatigue (no pre-stress on the fastener) the difference in fatigue strength between a bright and a heat-treated cap screw is not sufficient to offset the cost difference.
2. When bolting low strength materials, high clamping forces can cause the material under the bolt head to indent. Here the higher clamping force of the heat-treated screw offers no advantage.



Fastener costs were cut 37% when heat-treated cap screws were substituted for "brights" in this support plate.

3. In applications where joint rigidity requires a certain minimum number of fasteners, "brights" usually are the economical answer.
4. Greater availability from local sources simplifies field maintenance.

Heat-Treated Hex Cap Screw Advantages

1. In a rigid joint you get far more clamping force per dollar cost.
2. The shear strength per dollar cost is substantially higher.
3. When heads are exposed to abrasive conditions, heat-treated screws will sustain considerably less damage or wear.

Hold Inventories Down

Obviously, the best and cheapest screw for each job varies with the application. Unless you use a very large quantity of each grade, however, it is seldom wise to stock two grades of the same size and type of fastener, since this raises inventory costs. Normally the simplest and cheapest approach is to stock the stronger . . . or heat-treated . . . variety.

For Further Information

Our fastener specialists will be happy to give you further information or suggestions on specific applications. You can get in touch with them through your local Stanscrew distributor. He'll also be happy to supply you with any of Stanscrew's 5,500 different types and sizes of standard fasteners.



STANSCREW

FASTENERS

CHICAGO | THE CHICAGO SCREW COMPANY, BELLWOOD, ILLINOIS

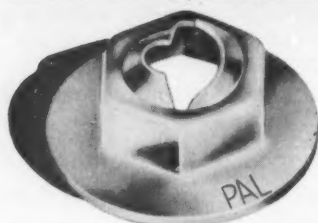
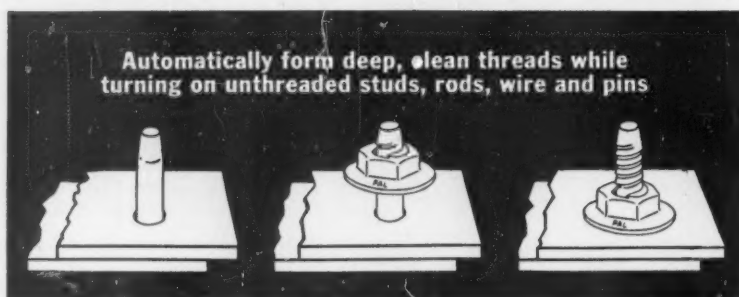
HMS | HARTFORD MACHINE SCREW COMPANY, HARTFORD, CONNECTICUT

WESTERN | THE WESTERN AUTOMATIC MACHINE SCREW COMPANY, ELYRIA, OHIO

STANDARD SCREW COMPANY 2701 Washington Boulevard, Bellwood, Illinois

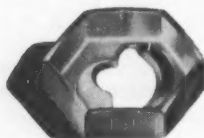
Save Threading Costs!

GET YOUR THREADS **FREE** by fastening with **PALNUT® SELF-THREADING NUTS**



WASHER TYPE—STYLE SD

One-piece self-threading nut performs functions of ordinary nut, lockwasher and flat washer. Resilient washer base avoids distortion of sheet metal or damage to fragile parts. Several base diameters; also with bonded-in plastisol compound to seal out water and dirt. Sizes for $\frac{1}{8}$ ", $\frac{1}{32}$ " and $\frac{3}{16}$ " dia. studs and rods.



REGULAR TYPE—STYLE SR

For assemblies where space is limited. Uses shorter studs, less seating area. Competitive with push-on fasteners, assembles fast, assures tight assemblies. May be used with internal wrench. Sizes for $\frac{1}{8}$ ", $\frac{1}{32}$ " and $\frac{3}{16}$ " dia. rod, in various hex widths.



ACORN TYPE—STYLE SC

Decorative, dome-shaped self-threading nut covers end of studs or rods to protect against scratching, snagging or tearing, while adding a pleasing appearance. Costs less than threaded cap nuts. Sizes for $\frac{1}{8}$ ", $\frac{1}{32}$ " and $\frac{3}{16}$ " dia. studs and rods.

Write for Bulletin 585-A and Free Samples, stating style, size and application.



THE PALNUT COMPANY

Division of United-Carr Fastener Corp.

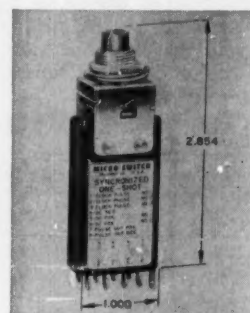
75 Glen Road, Mountainside, N. J.

Canada: P. L. Robertson Mfg. Co., Ltd., Milton, Ont.

LOCK NUTS and FASTENERS

NEW PARTS AND MATERIALS

clock pulse at each operation, with pulse frequencies from 4 to 500 kc. Compact, pre-engineered mechanisms save space and time required to develop flip-flop and gating networks for synchronizing one-shot circuits. All circuit components are sealed in resilient potting material for protection from physical damage and moisture. Assemblies can be used for manually loading magnetic drums, checking ring counters, re-



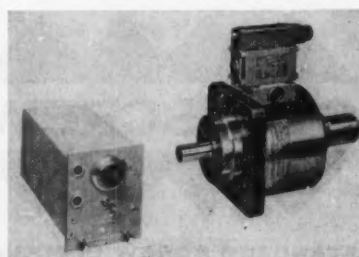
setting flip-flops, radar, telemetering, data reduction, and test equipment. Assemblies fit a variety of dc supply voltages, clock pulse rise times, voltages, and frequencies. Micro Switch Div., Minneapolis-Honeywell Regulator Co., Freeport, Ill.

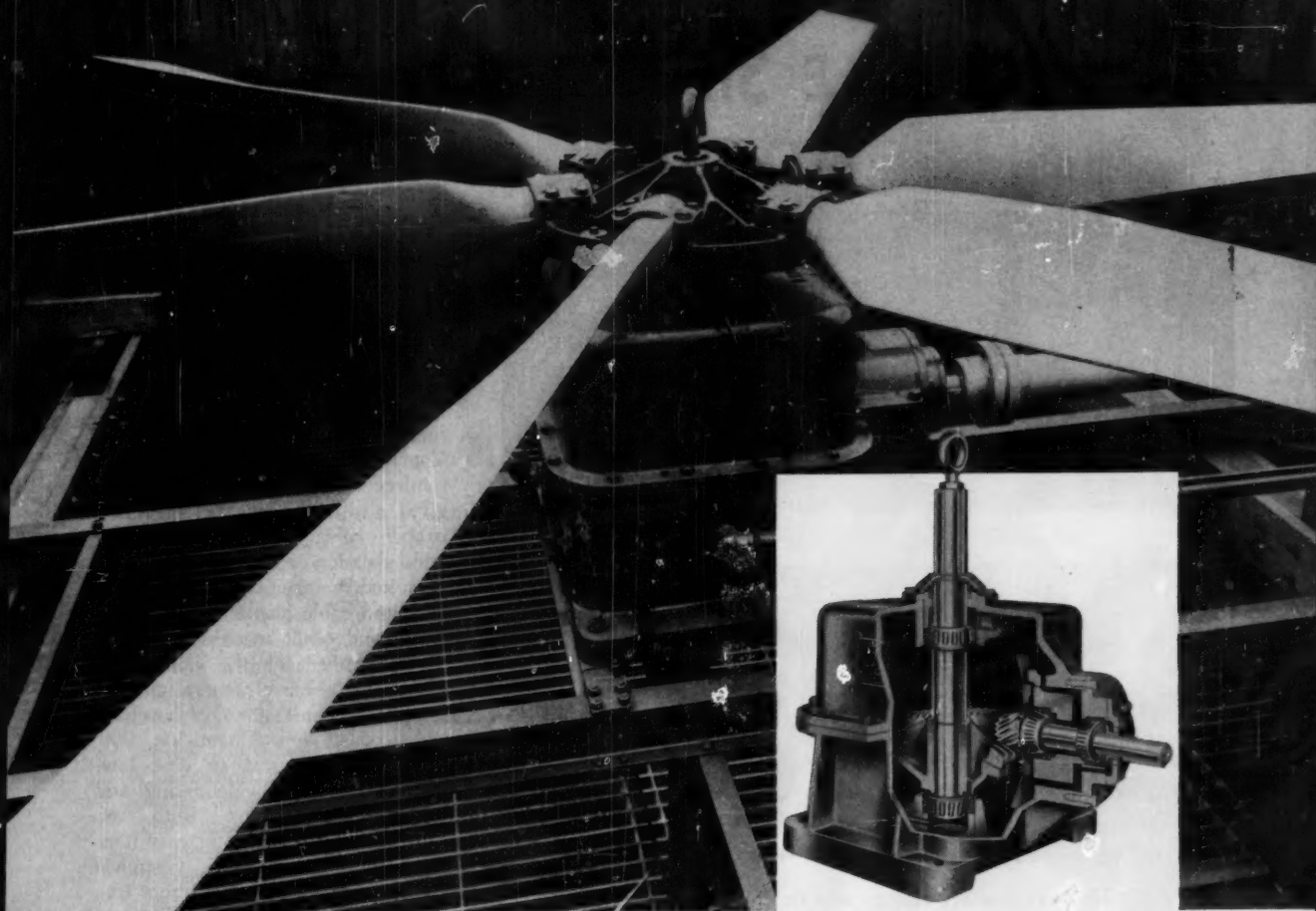
Circle 740 on Page 19

Servo-Drive Systems

are high-performance
variable-speed units

Notable characteristic of Series 540 servo-drive systems is performance of drive in zero speed region where speed regulation, no load to full load, and long-term speed stability are typically of the order of 0.1 rpm. Coupled with high available torque, this characteristic enables direct coupling of servo drive to such loads as machine-tool lead screws without intermediate gear reduction. No load to full-load regulation at high end of speed range is about 0.2 per cent, and actual speed





This spiral bevel gear combination permits the flexibility required to meet rugged 24-hour service while providing an economical, self-contained unit which requires practically no maintenance.

How to obtain help when you design bevel gear assemblies

The men who designed the gear reducer for the cooling tower fan shown above were assisted in many ways by Gleason engineers.

Cooling tower fan operation is generally recognized to be one of the most severe tests to which a gear reducer can be subjected. These towers demand a gear system that can operate twenty-four hours a day, three hundred and sixty-five days a year if necessary.

The gear reducer is subject to heavy loads and lies in the path of moist, corrosive air streams.



The gear drives for these cooling tower fans are subject to heavy loads and lie directly in path of moist, corrosive air streams.

Here is what the customer and Gleason engineers developed.

A spiral bevel drive of 19 x 76 combination and 2.5 DP. With spiral bevel gears the tooth bearing is localized which assures smooth and quiet operation and permits some mounting deflections without concentrating the load dangerously near either end of the tooth.

The use of this gear design also allowed the flexibility required to fit the fan unit into the over-all design of the tower and to produce an economical, self-contained unit which requires little or no maintenance.

Next, our engineers produced and tested prototypes of the design which the cus-

tomers in turn tested in the final product.

Our engineers can also help you select proper mountings for such gear assemblies and advise you on such details as lubrication.

If you would like to take advantage of this service, write us the next time you have a problem involving bevel or hypoid gear systems. Furnish data covering type of application, loads and speeds and prints of the mountings. We would be pleased to assist you in the selection of your gears.

Meanwhile, you may find these Gleason Technical Handbooks helpful in your work:

- "20° Straight Bevel Gear System"
- "Spiral Bevel Gear System"
- "ZEROL Bevel Gear System"



GLEASON WORKS

1000 UNIVERSITY AVE., ROCHESTER 3, N. Y.

Circle 552 on Page 19

STOW FLEXIBLE SHAFTING

The Ideal PTO Drive



1 1/4" flexible shaft under tractor-trailer transmitting 10 HP.



1 1/4" core assembly pulled out of casing. Note steel-backed bronze sleeve bearing.

Here are five big reasons why flexible shafting is an ideal power take-off drive on trucks and tractor trailers.

FLEXIBLE SHAFTING:

1. Can connect a drive shaft and a driven shaft which are working at different angles and located in different planes.
2. Eliminates the need for accurate alignment.
3. Eliminates dangerously exposed revolving parts; no safety guards required.
4. Replaces connections affected by vibration.
5. Is economical because it is so easy to install and maintain.

Available with built-in bearings and couplings in sizes from 1/4 inch to 1 1/4 inches in diameter—STOW flexible shafting can help solve your trucking and maintenance problems *in advance*. The know-how of 85 years' experience goes into every STOW flexible shaft!

STOW flexible shafts are being used on trucks and tractor-trailers to:

- Operate pumps for petroleum, other liquids and hydraulic pumps on dump trailers.

- Operate conveyors for grain and coal.
- Operate compressors on refrigeration trucks.

Our Engineering Department will be glad to work with you on any special drive problems. For complete data on flexible shafting sizes, torque capacities, and other specifications, write for STOW Engineering Bulletin, No. 570, and Tractor-Trailer Bulletin, No. 542.



STOW MANUFACTURING CO.

11 Shear St.

Binghamton, New York

NEW PARTS AND MATERIALS

is within 1 per cent of setting on speed-control dial. **Pegasus Laboratories Inc.**, 3690 Eleven Mile Rd., Berkley, Mich.

Circle 741 on Page 19

Oil-Resistant Elastomer

of nitrile-type rubber and vinyl resin

New family of elastomers, Chemi-Vic, has excellent resistance to oil, fuel, abrasion, ozone, and weather. Composed of a nitrile-type rubber reinforced with vinyl resin, material gives all the advantages of nitrile rubber plus outstanding ozone and abrasion resistance. Material is suited for such applications as wire and cable insulation, hose covering, and other mechanical goods. Two members of the family are Chemi-Vic 400, a general-purpose material for all types of mechanical goods, and Chemi-Vic 800, specifically designed to give low-mill shrinkage in calendering and extruding operations. Both are available in slab form for easy handling and processing. **Chemical Div., Goodyear Tire & Rubber Co.**, Akron 16, Ohio.

Circle 742 on Page 19

Prebonding Compound

for Teflon, TFE, FEP, KEL-F surfaces

Bondaid compound prepares Teflon, TFE, FEP, and Kel-F surfaces for bonding to other materials. Included among the materials to which the process makes fluorocarbons bondable are metals, other plastics, glass ceramics, textiles, woods, and virtually all other solids to which the bonding of fluorocarbons might be considered. Compound can be applied to an entire piece or to a limited area. It prepares surface of material to be bonded for use with any standard adhesive which other characteristics of the particular application would recommend. Among the adhesives are epoxies, phenolics, rubber, and silicones. Bondaid can be color-coded for identification of a fluorocarbon. **Polytex Div., W. S. Shamban & Co.**, Box 1037, Culver City, Calif.

Circle 743 on Page 19

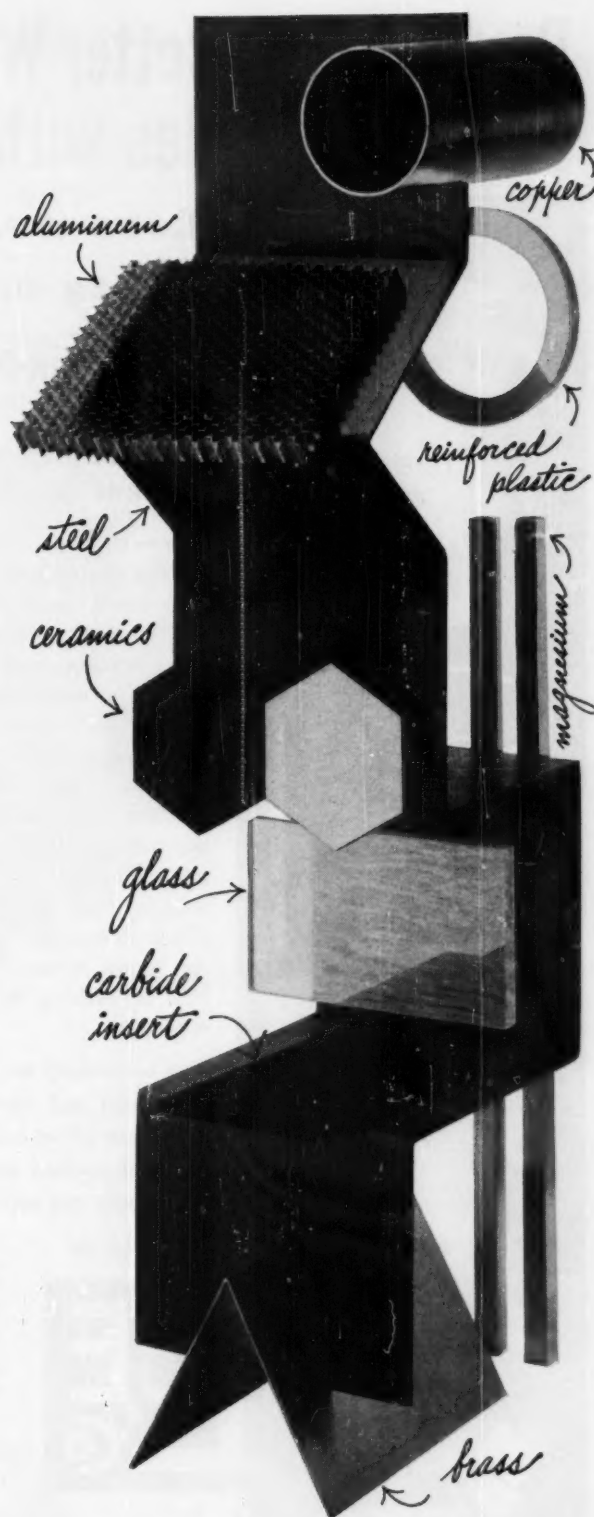
WHAT DO YOU WANT TO BOND TO WHAT?

Take a structural material—for instance, any of the materials shown to the right. Want to join it to itself or another material? Then chances are that SCOTCH-WELD® Brand Structural Adhesives are your best fabricating answer. This modern high strength method of joining materials permits improved design and production techniques . . . cuts costs . . . offers unique benefits.

For example: Smoother contours result when mechanical fasteners are eliminated. Fabricating complex shapes—often impossible or too expensive with ordinary fastenings—is made easy and economical with SCOTCH-WELD Adhesives. In fact, costly complex castings can often be replaced by two or more inexpensive simple castings bonded together with SCOTCH-WELD Adhesives. And lighter gage materials may be used where desired, since stress is spread over a wide area. Often, too, inspection and production steps can be eliminated. Another benefit—unusual combinations of materials which can be joined in no other way can be bonded perfectly with SCOTCH-WELD Adhesives.

Throughout the metalworking industry, bonding with SCOTCH-WELD Brand Structural Adhesives is improving quality, speeding production and cutting costs.

SCOTCH-WELD Adhesives may be the answer to your design and production problems . . . and improve your product at the same time. For full information write on your company letterhead, outlining area of interest, to: AC&S Division, 3M Company, Dept. SBR-60, St. Paul 6, Minn. "SCOTCH-WELD" is a Reg. T.M. of 3M Co.



ADHESIVES, COATINGS AND SEALERS DIVISION

MINNESOTA MINING AND MANUFACTURING COMPANY

... WHERE RESEARCH IS THE KEY TO TOMORROW



Proved! New, Better Way to Seal Drilled Holes with . . .

Less weight!

Less cost!

NEW PIN-PLUGS®

**Seal simply, positively
Prevent costly leaks!**

Now — forget conventional, costly methods of sealing holes that serve as flow or pressure passages. The Lee "Pin Plug" is a cylindrical plug with a tapered reamed hole partway through its center and numerous small grooves on its outside surface. Simply place it into reamed hole and drive in the tapered pin until ends are flush. Controlled expansion causes grooves in plug to "bite" into casting and form independent seals and retaining rings. Extensive laboratory tests report no leaks under normal pressures, often show bone dry seals up to pressures of 40,000 psi.

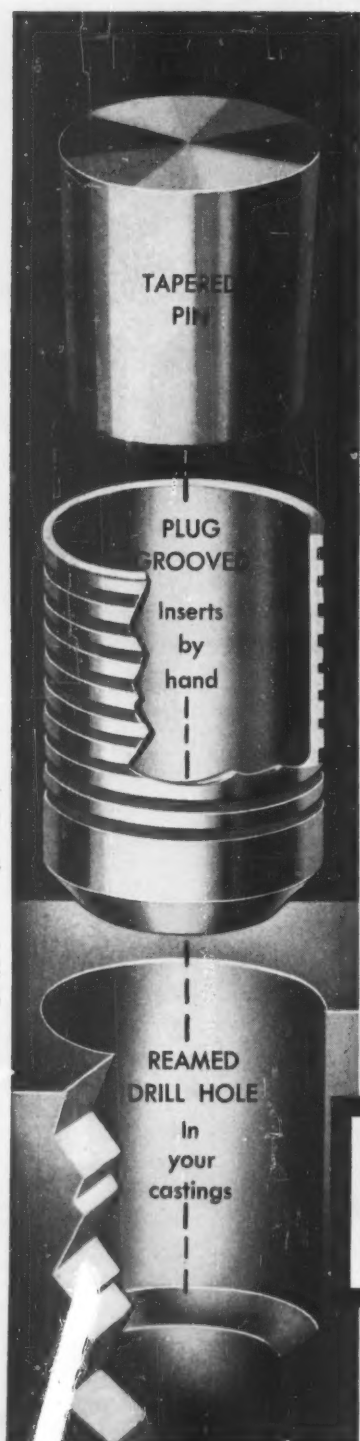
Now successfully and widely used on aircraft and missiles — for pumps, servo valves, regulators, etc. Available steel and aluminum and in both long and short series.

Pat #2,821,323



SOME TERRITORIES STILL OPEN FOR QUALIFIED TECHNICAL SALES REPRESENTATIVES.

Write today for Standard Sizes and Engineering Data



THE LEE COMPANY OLD SAYBROOK, CONN.

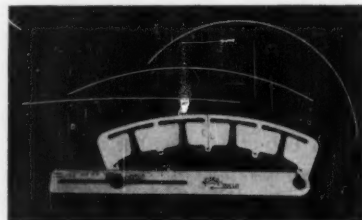
ENGINEERING
DEPARTMENT

EQUIPMENT

Arc Ruler

draws arcs of circles
from 7 to 200 radius

Acu Arc ruler provides a rapid, accurate means of drawing arcs of circles of large radii. Rulers draw arcs of circles of any radius from 7 to 200 in. or more with ease, even if center point of circle is beyond the edge of drawing surface. Movable pointer on a scale reading ra-



dus length directly gives exact arc required. Center lines, center points, and radii for arcs already drawn can be determined quickly and easily. Ruling edge is 12 in. long. Fullerton Engineering Sales Co., 4623 York Blvd., Los Angeles 41, Calif.

Circle 744 on Page 19

Solid-State Calculator

high-speed, punched-card unit
has many applications

No. 609 calculator is a low-cost, solid-state punched-card unit adaptable to a broad range of commercial, industrial, and engineering applications. A high-speed machine, it performs additions and subtractions at microsecond speeds and multiplications and divisions in milliseconds. Machine combines the functions of input, calculation, storage, and output into a single unit only 60 in. long, 20 in. wide, and 50 in. high. Unit uses any grounded 115-v, 60-cycle, single-phase, ac outlet. Calculator is programmed by wire control panels which can be changed quickly and easily when switching from



job to job. All steps are nonsequential, permitting the unit to make logical decisions as to what steps should be used to solve a problem without regard to their sequence. Input and output are by means of standard 80-column punched cards. Indicator lights on the display panel show the complete operational status at any given moment, providing an effective means of communication with the machine. **Data Processing Div., International Business Machines Corp., 112 E. Post Rd., White Plains, N. Y.**

Circle 745 on Page 19

DC Power Supply

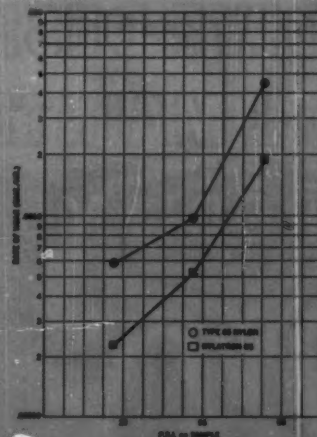
for use in transistor circuit design

Transistorized, regulated, variable-voltage power supply, Model PS-3, is available for use in transistor circuit design, and provides most of the voltages and currents, as well as filtering, required for work with transistors. Unit features extremely low ripple. Voltage remains essentially constant at any output voltage setting regardless of load (within ratings), and regardless of ac supply voltage fluctuations. The 2 per cent D'Arsenal meter has three ranges. Zener-diode reference is used in the three-transistor regulating circuit. Heavy overloads or shorts can-



June 23, 1960

Specimens run
against steel
—not lubricated.



As a dry bearing, NYLATRON® GS Nylon can be used at 50% higher PV (pressure & velocity) ratings than standard type 66 nylon, because it runs cooler, smoother and quieter with less friction to generate heat... maintains established fits and running clearances over a greater temperature range... and offers more rigid thin sections.

look
how much more
wear resistance

NYLATRON GS Nylon gives your product

Increased abrasion resistance is only one advantage of NYLATRON GS over ordinary nylon. The nylon plus moly-sulphide composition* gives mechanical parts greater dimensional stability, increased modulus of elasticity, and improved flexural strength. In addition, GS Nylon molds accurately, ejects rapidly and handles easily on standard injection molding equipment.

Consider these NYLATRON GS advantages on your next design job. They promise you a superior product and cost-saving production.

For complete information about the unique properties and advantages of NYLATRON GS Nylon, call or write The Polymer Corporation

*Patented



POLYPENCO Industrial plastics

The Polymer Corporation • Molding Resins Division

Reading, Pa.

Circle 556 on Page 19

239

SOLVE DESIGN and MAINTENANCE PROBLEMS



Stratoflex was specified for the precision hydraulic tracing control kit on this tool room milling machine.

When you design with Stratoflex you get more than the vibration and stress resistance inherent in flexible hose. You get hose fittings designed to meet your specific requirements. And with Stratoflex leak-proof reusable fittings you simplify maintenance by making possible quick, easy replacement or modification. You solve both design and maintenance problems when you specify Stratoflex.

Write for
Bulletin
S-2 today

SF10-9

STRATOFLEX

P.O. Box 10398 Fort Worth, Texas
Branch Plants: Hawthorne, Cal., Fort Wayne, Toronto
In Canada: Stratoflex of Canada, Inc.

SALES OFFICES:

Atlanta, Chicago
Cleveland, Dayton
Detroit, Fort Wayne
Fort Worth, Hawthorne
Houston, Kansas City
Milwaukee, New York
Philadelphia, Pittsburgh
San Francisco, Seattle
Toronto, Tulsa

ENGINEERING DEPT. EQUIPMENT

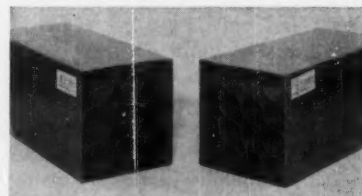
not damage the unit. Output voltage is 0-15 v at 0-200 ma, and 0-25 v at 0-100 ma. Input voltage is 110 to 130 v, 60 cycles. Electro Products Laboratories Inc., 4500 N. Ravenswood Ave., Chicago 40, Ill.

Circle 746 on Page 19

Roll Files

in 9 or 16-tube models
are for large drawings

Multiroll 9 and 16-tube roll files accommodate material up to 42 in. long. Rear openings are closed to



prevent air circulation. Tubes are encased in reinforced corrugated board container and secured to produce a strong assembly. Both 9 and 16-tube models are available in 30, 36, and 42-in. lengths. Visual index record form is furnished with each unit. Roll & File Systems Inc., P. O. Box 3863, Detroit 5, Mich.

Circle 747 on Page 19

Modular Power Supply

provides two outputs of
positive and negative current

Model RS-473 modular power supply provides two outputs of positive 300-400 and negative 300-400 v, or a single output of 600-800 v. Ranges are available at currents to 25 ma. Both supplies track each other throughout their ranges with single voltage-adjustment control located at top of chassis. Recovery time is



less than 25 microsec, and internal impedance is less than 1 ohm. Trans Electronics Inc., 7349 Canoga Ave., Canoga Park, Calif.

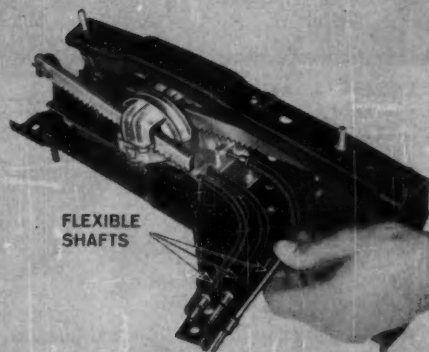
Circle 748 on Page 19

S.S. White

DRIVE AND CONTROL IDEAS FOR ENGINEERS



HEART OF THE POWER-SEAT MECHANISM... Two slave units, on the left and right sides of seat, are driven by flexible shafts to provide three-way motion. A single 1/4-hp motor attached to a geared drive unit is the power source. Flexible shafts rotate at 1250 rpm, carry 9 in.-lbs. of torque at running load (three persons) and 15 in.-lbs. at full stall speed.



Flexible Shafts Solve Space Problems in Chrysler Power-Seat

Chrysler Corporation faced a design challenge in its power-operated seat adjuster. Six-way motion was called for: fore and aft, up and down, and tilt. Yet there was limited space under the seat for the mechanism. After much Chrysler testing and development, a design submitted by subcontractor Ferro Stamping Company was approved, utilizing flexible shafts.

According to Chrysler, the decision to go to flexible shafts was based on the following advantages:

1. SPACE ECONOMY... "flexible shafts provided means to transmit power from a single elec-

tric motor, without compromising seat design."

2. REDUCED STRESSES... "flexible shafts act as torsion bars to reduce motor armature stresses induced when the mechanism was stopped or stalled suddenly."

3. RELIABILITY... "not a single shaft fatigue failure reported from the field to date."

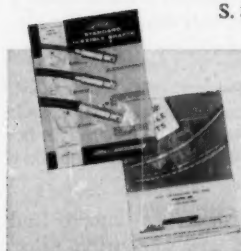
4. LOW COST... "flexible shafts definitely represented savings without sacrificing design advantages."

Investigate for yourself how flexible shafts can solve many of your design problems and at the same time reduce costs!

S. S. White Industrial Division Dept. 4,

10 East 40th Street, New York 16, N. Y.

1098



WRITE FOR COMPLETE DATA

Standard S. S. White flexible shafts are available "off the shelf," making many savings possible. Write for bulletin 5601.

S. S. White also offers engineering service and comprehensive selection of flexible shaft sizes and types to meet special requirements. Write for bulletin 5601.



HILLIARD *Clutches* FOR POWER CONTROL DESIGN

ADJUSTABLE

Slip Clutch

- PROTECTS against overload, jams and down time.
- RESUMES THE DRIVE AUTOMATICALLY after overload.
- ELIMINATES SHEAR PINS and lost time.
- ADJUSTABLE - WHILE - RUNNING feature is available.

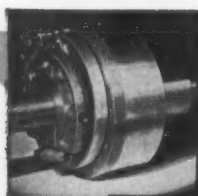
Hilliard Slip Clutches are continuously protecting the drive on dish washing machines—printing presses—packaging machines—case loaders—foundry equipment—air filters—conveyors—overhead doors—and many others. They maintain steady torque while permitting speed variation on fabric drying drums, steel strip slitters and similar equipment.

The adjustable-while-running types are used to maintain constant tension on rewind stands for paper coaters, textile machines, rope, steel and wire mills and for drive systems requiring overload protection but which must be disconnected at times.

➔ WRITE TODAY FOR BULLETIN 300 WITH COMPLETE INFORMATION.

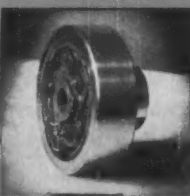
• OTHER HILLIARD CLUTCHES •

CONSIDER AUTOMATION - INVESTIGATE THESE PRODUCTS



SINGLE REVOLUTION CLUTCHES for automatic accurate control—electrical or mechanical—of intermittent motion, indexing, cycling and cut-off. Ask for Bulletin 239.

HILLIARD - TWIFLEX CENTRIFUGAL COUPLING for smooth, easy starting of any load automatically with overload protection and ability to accommodate shaft misalignment. Ask for Bulletin CE-3.



OVER - RUNNING CLUTCHES for automatic instantaneous engagement and release on two speed drives, dual drives and ratchet, or backstop action. Ask for Bulletin 231.

THE HILLIARD *Corporation*

MANUFACTURING CLUTCHES FOR OVER 50 YEARS

103 WEST FOURTH ST., ELMIRA, N. Y.

IN CANADA: UPTON • BRADEEN • JAMES, LTD.

Please direct inquiries to advertiser, mentioning MACHINE DESIGN

THE ENGINEER'S

Library

Recent Books

Acronyms Dictionary. 192 pages, 5½ by 8 in., clothbound; published by Gale Research Co., 1116 Book Tower, Detroit 26, Mich.; available from MACHINE DESIGN, \$10.00 per copy postpaid.

This dictionary is a guide to alphabetic designations for associations, societies, colleges and universities, government agencies, business firms, general terms, and other designations. More than 12,000 acronyms are listed.

Managing Technician Manpower. By J. T. Brady, C. O. Gale Jr., R. C. Hodgson, J. W. Johnson, W. E. Moran, A. M. Rouse, R. Z. Zorenson, and R. Stinson Jr.; 172 pages, 8½ by 11 in., paperbound; published by Technician Manpower Associates, Box 158, Scarsdale, N. Y.; available from MACHINE DESIGN, \$18.50 per copy postpaid.

This documented report is based on a survey of more than 80 corporations, and many unions, trade associations, and educational institutions concerned with the training and utilization of engineering and scientific supporting personnel. Major purpose is to clarify and relate factors which should go into industry's development of a policy for managing its technician group more effectively.

Some topics discussed are defining and training technicians, the technician and collective bargaining, hiring of technicians, and the technician views his career.

A series of articles which appeared in the May 12 to June 23, 1960, issues of MACHINE DESIGN ("The Technician: Engineering Semipro?") was based on this book.

The New Product. By Delmar W. Karger; 234 pages, 6 by 9 in., clothbound; published by and available from The Industrial Press, 93 Worth St., New York 13, N. Y.; \$5.00 per copy.

This book describes how to find ideas for, and how to develop, price,

MACHINE DESIGN

PRODUCT-DESIGN BRIEFS FROM DUREZ

- What a solvent cement can do
- Something new in electrical insulation
- A bulletin on plastics

Stuck?

A good adhesive does a lot more than stick two things together. You can use



today's solvent-type adhesives to:

- smooth out surface contours (as in brake linings and in jet aircraft skins, where adhesives can eliminate the need for projecting rivets);
- distribute stress uniformly over a surface, rather than concentrating it at welded or riveted points;
- build up large structural members from many small components;
- reduce galvanic action between dissimilar metals, and so lessen the risk of corrosion.

One super-sticker in this class sets with only contact pressure and at room temperature; adheres very well to metal, wood, phenolic laminates, glass, and rubber. Block shear tests show 4500 psi at room temperature, and tensile strength is 10,000 psi. The cement has excellent resistance to all ordinary solvents, water, oils, alkalies, and acids; has high capillary attraction and does not shrink.

We don't make adhesives. We do make heat-setting phenolic resins that give many of the newer adhesives more gripping power and more *permanence*. Next time you have a fastening problem, give these new solvent-type adhesives a chance to show you what they can do.

Stock Insulation shapes

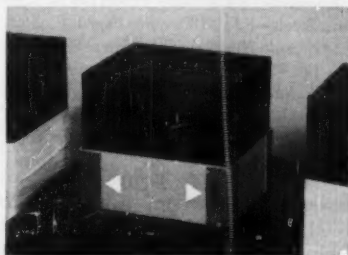
This insulation idea solves three engineering problems at once in a dry-type transformer. You'd find the same ap-

proach helpful in a circuit breaker, a panel, or other heavy-duty electrical gear.

See the plastic angle pieces (below)? They insulate the corners of the laminated steel core from the windings, at the high-stress areas. They take the place of roll-formed fiber. Advantages:

1. Greater mechanical strength. This ends cracking or breaking of insulation when windings are forced into position.
2. Better resistance to moisture. The insulation doesn't swell or shrink, maintains its dielectric strength under the clammiest conditions.
3. Higher heat resistance. The angle is made with glass-reinforced Hetron,[®] our inherently heat-resistant polyester resin. It meets NEMA GPO-1 specifications, and has UL-recognized flame retardance. It is designed for equipment operating at Class B temperatures (266° F.).

Now for the clincher. You can get flame-retardant structural insulation



PRECISION WELDER AND FLEXOPRESS CORP.

like this *from stock*—in a wide range of cross-section shapes including channels, in widths up to 9²¹/₃₂ inches, lengths to 76 inches.

You get them not from us but from the manufacturer, The Glastic Corporation, 4321 Glenridge Road, Cleveland 21, Ohio. The Glastic people will be glad to send you details on stock channels and angles if you write to them.



Facts without a file

What does a man do when he wants to know more about Durez plastics?

He looks in Sweet's File. There he finds eight pages packed with the what, how, when, where, and why of using Durez materials—phenolic and diallyl phthalate molding compounds, Hetron polyester resins, phenolic resins.

What if he hasn't got Sweet's File handy? He sends us the coupon below, requesting Durez *Bulletin D400*. The same fact-filled eight pages come to him posthaste.

For more information on Durez materials mentioned above, check here:

- ☐ Phenolic resins (12-page bulletin listing applications)
- ☐ Hetron fire-retardant polyester resins (data file, including names of fabricators)
- ☐ Durez plastics (*Bulletin D400*)

Clip and mail to us with your name, title, company address. (When requesting samples, please use business letterhead)

DUREZ PLASTICS DIVISION

506 WALCK ROAD, NORTH TONAWANDA, N. Y.

HOOVER CHEMICAL CORPORATION



"the
HITCHINER
way..."



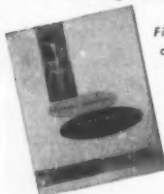
...and
non-machinable
super alloys
in
INVESTMENT CASTING

These spray nozzles for highway stripping paint sprayers were formerly machined out of cold rolled bar stock. When ordinary paint was used, these nozzles functioned satisfactorily. However, when ground glass was added to the paint for reflecting purposes excessive wear caused frequent replacement.

By "the HITCHINER way . . .", we were able to engineer the manufacture of this part by investment casting in a non-machinable type alloy exhibiting a very high degree of resistance to both wear and corrosion.

This change of alloy, which eliminated the need for frequent nozzle replacement, was made possible through investment casting because the required close dimensional tolerances and detail could be cast to size.

Through the wide freedom of choice in alloy, as well as through flexibility in design and the elimination of expensive machining operations, investment casting may possibly solve your metal parts manufacturing problems. Send us your sample or blueprint and find out with a Hitchiner "engineered quotation" — no obligation.



Find out how our new ceramic shell technique can possibly benefit you. Send for our free, new revised brochure on the latest investment casting methods.

HITCHINER
MANUFACTURING COMPANY INC.
MILFORD 31, NEW HAMPSHIRE

Coast to Coast Engineering Representatives

ENGINEER'S LIBRARY

advertise, and sell new products. Checklists that aid in avoiding common pitfalls are presented.

Entire subject is approached from viewpoint of general management. Basic concepts of top-management planning and organizing for new product development are covered. Each major functional area of the business enterprise pertaining to development and marketing of new products is also covered.

Association Publications

Proceedings of 15th Annual Conference—American Society of Industrial Designers. 18 pages, 9 by 12 in., paperbound, stapled; available from American Society of Industrial Designers, 15 East 48 St., New York 17, N. Y.; \$0.85 per copy.

General area of discussion was planning by design in a world of product change. Some specific topics included in the 14 papers are design in industrial equipment, human-factors engineering in product development, re-evaluating product planning in industry, developing corporate design consciousness, and interpreting tastes in products.

Elevated-Temperature Properties of Carbon Steels—STP 180. By Ward F. Simmons and Howard C. Cross; 68 pages, 8½ by 11 in., paperbound, stapled; published by and available from American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa.; \$3.75 per copy.

Mechanical properties of various carbon steels at temperatures up to 1400 F are presented. This report includes data for tensile and yield strength, elongation and reduction of area, stresses for creep rates of 0.0001 and 0.00001 per cent per hr, and rupture strengths for 100, 1000, 10,000, and 100,000 hr.

Literature Surveys on Influence of Stress Concentrations at Elevated Temperatures and the Effects of Nonsteady Load and Temperature Conditions on the Creep of Metals—STP 260. By W. F. Brown Jr., S. S. Manson, G. Sachs, and J. G. Sessler; 108 pages, 8½ by 11 in., paperbound, stapled; published by and available from American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa.; \$4.50 per copy.

The survey on stress concentrations reviews the available notch-

TIPS

AND

T
E
C
H
N
I
Q
U
E
S

VOLUME II ENGINEERING AIDS

- Simplifying Constructions
- Utilizing the Slide Rule
- Construction Aids
- Shortcuts for the Engineer

Helpful Tips and Techniques that apply to engineering methods, are now available in this one-volume reference. This manual contains 32 pages of illustrated time-and-money saving procedures that every engineer can use.

\$1.00 a copy

Order from

MACHINE DESIGN

Reader Service
Penton Building
Cleveland 13, Ohio

(Remittance or Company Purchase Order must be enclosed with order)

rupture data to establish fundamental influences of stress concentrations, testing variables, and influence of alloy compositions. A section dealing with application of notch data to component design is included.

The survey on effects of non-steady load and temperature conditions on creep of metals describes fundamental investigations, summarizes data on alloys under complex variations of load and temperature, and reviews analytical procedures for calculating nonsteady behavior from steady-state tests.

Government Publications

OTS Technical Reports. Copies of reports listed below are available from Office of Technical Services, U. S. Dept. of Commerce, Washington 25, D. C.

PB 161107. Second Symposium on Electronics Maintenance—Design for Ease of Maintenance. 208 pages, 8 by 10 in., paperbound, stapled; \$3.50 per copy.

Recently published, this report of the May, 1956, symposium covers methods for ensuring proper initial design of electronic equipment. The major premise discussed is that if initial design is good, functions of trouble shooting, maintenance records, calibration, replacement, and repair are simplified.

Some specific topics included in the 23 papers are principles for designing maintainability into electronic equipment, design of procedures for systematic trouble shooting, and application of human factors to signal equipment design.

PB 161164. Physical and Mechanical Properties of Molybdenum and the Mo-0.5 Ti Alloy. By Richard W. Douglass, Battelle Memorial Institute; 23 pages, 8½ by 11 in., paperbound, stapled; \$0.50 per copy.

Physical properties of molybdenum and the Mo-0.5 Ti alloy at elevated temperatures, and mechanical properties over a wide range of temperatures are presented. Included are tensile, impact, and fatigue data, and creep and stress-rupture properties.

PB 161170. The Properties of Magnesium-Thorium Alloys. By R. J. Jackson, Battelle Memorial Institute; 29 pages, 8½ by 11 in., paperbound, stapled; \$0.50 per copy.

Engineering data on magnesium-thorium alloys for use in structures and airframes are presented. Also, fabrication of these alloys and design requirements favoring their selection are discussed.

PB 161190. A Brief Review of Refractory Metals. By R. I. Jaffee, Battelle Memorial Institute; 34 pages, 8½ by 11 in., paperbound, stapled; \$0.50 per copy.

Mechanical and physical properties of twelve refractory metals are presented. Included are chromium, molybdenum, vanadium, tungsten, columbium, tantalum, rhenium, and the platinum-group metals.

PB 161322. Weld Flaw Evaluation. By Samuel T. Carpenter and Roy F. Linsenmeyer, Swarthmore College; 117 pages, 8 by 10½ in., paperbound, stapled; \$2.75 per copy.

Effects of weld flaws in various environments were examined to determine the environment essential to initiate brittle fracture under low static-stress conditions. Brittle-fracture mechanics, static tests on flawed butt welds, static and dynamic tests on small butt-weld flaws with and without residual stress, and static tests on weld flaws in a controlled field of high residual stress are discussed.

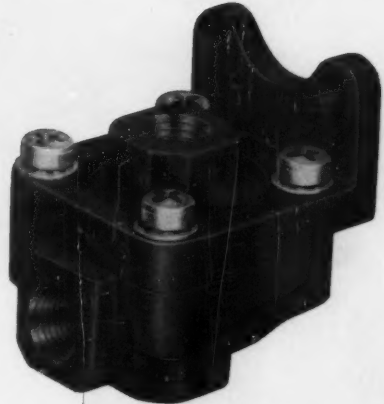
PB 161323. Evaluation of Weld-Joint Flaws as Initiating Points of Brittle Fracture. By R. P. Sopher, A. L. Lowe Jr., and P. J. Rieppel, all from Battelle Memorial Institute; 51 pages, 8 by 10½ in., paperbound, stapled; \$1.50 per copy.

This report describes the conditions needed to initiate brittle fracture from weld flaws four inches long or less. Results of tests are tabulated and discussed.

Another new Westinghouse AIR CIRCUITRY Component

SHUTTLE VALVE

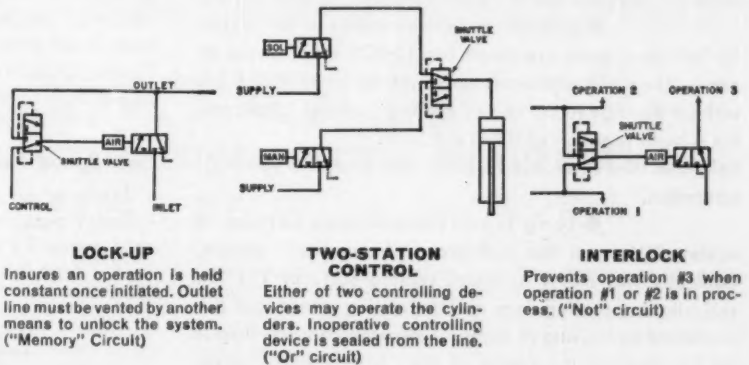
The Westinghouse Shuttle Valve automatically selects and directs the flow of air from one or the other of two controlling devices to a common outlet. It serves to connect two independent lines to a common line without destroying the segregation. A few of its uses are shown below.



Simple—Lightweight—Sensitive It contains only one moving part—an easily replaceable rubber diaphragm. Two body segments, a gasket and four screws complete the assembly. It has no springs. Nothing can bind or stick. Its compact size presents no installation problem.

Weighing only **6 ounces**, it can easily be supported by piping alone. Mounting feet are included, however, for installation with vibration or long pipe runs. It is so sensitive that it will seal off the opposite inlet line with less than 1 psi pressure differential.

TYPICAL APPLICATIONS



AIR CIRCUITRY means trouble-free automation

Air Circuitry is the application of pneumatic control systems to industrial production operations.

Air circuits are safe, economical and precise and are used to solve the most rigorous and complex control problems in industry.

Our engineers, backed by 90 years of experience, can help you boost production and cut costs in your plant.

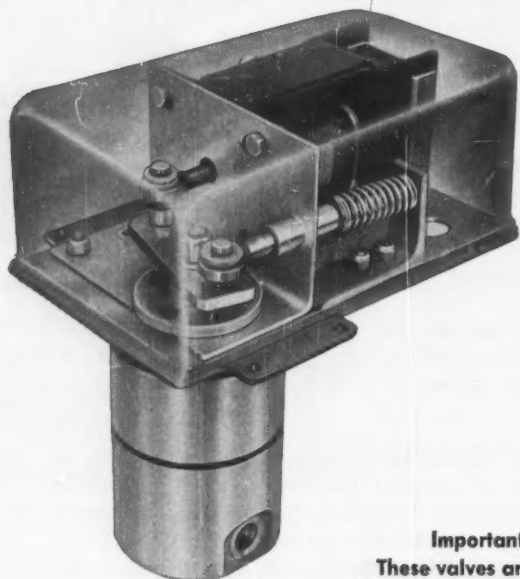
For more information, ask for Data Sheet A6-104-02

See the Yellow Pages under Cylinders for the Name of Your Local Distributor, or refer to Sweet's Catalog, Product Design File.



WESTINGHOUSE AIR BRAKE COMPANY
INDUSTRIAL PRODUCTS DIVISION, WILMERDING, PENNSYLVANIA

10,000 P.S.I. SOLENOID VALVES



Important:
These valves are
standard catalog items.

● They are available for immediate delivery (in stock) at standard valve prices, for a service which generally requires costly (made-to-order) special valves.

● Shut off and 4-way valves in $\frac{1}{4}$, $\frac{3}{8}$ and $\frac{1}{2}$ inch port sizes are rated for 10,000 P.S.I. liquid or gases. They will withstand surges of up to 15,000 P.S.I. without damage to the valves' sealing qualities (designed for a burst pressure of 30,000 P.S.I.).

Solenoids are available for 115, 230 and 460 volt A.C. operation.

● Long maintenance-free service is achieved through the leak-proof "Shear-Seal" design. Optically flat metal to metal sealing surfaces (of the self-aligning sealing rings and the mating rotor face) are protected by staying in constant intimate contact: flow is always through the center of the "Shear-Seals," never across sealing surfaces. Sealing qualities actually improve as the seals lap themselves to a more perfect fit with each valve operation. There is no external shaft leakage because the pressure is confined to the flow passages.

For complete data write
for catalog S-10000.



CONTROL VALVE DIVISION

Barksdale valves

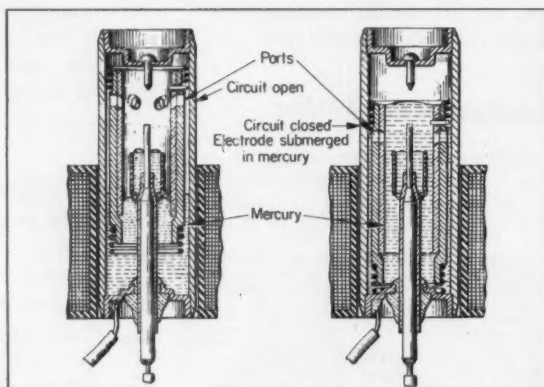
5125 ALCOA AVENUE • LOS ANGELES 58 • CALIFORNIA

NOTEWORTHY

Patents

Overload Protected Mercury Switch

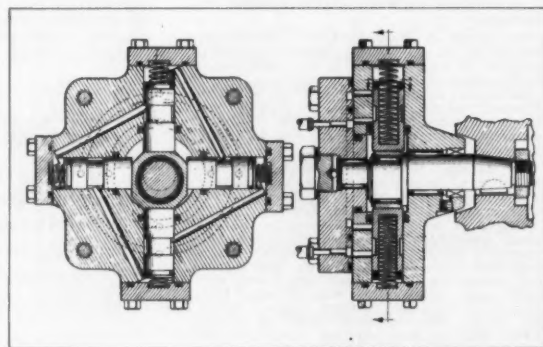
Ports in the immersing plunger of a mercury switch keep the mercury level within safe limits to prevent damage to the switch under severe overload conditions. Mercury which reaches the level of the ports is returned



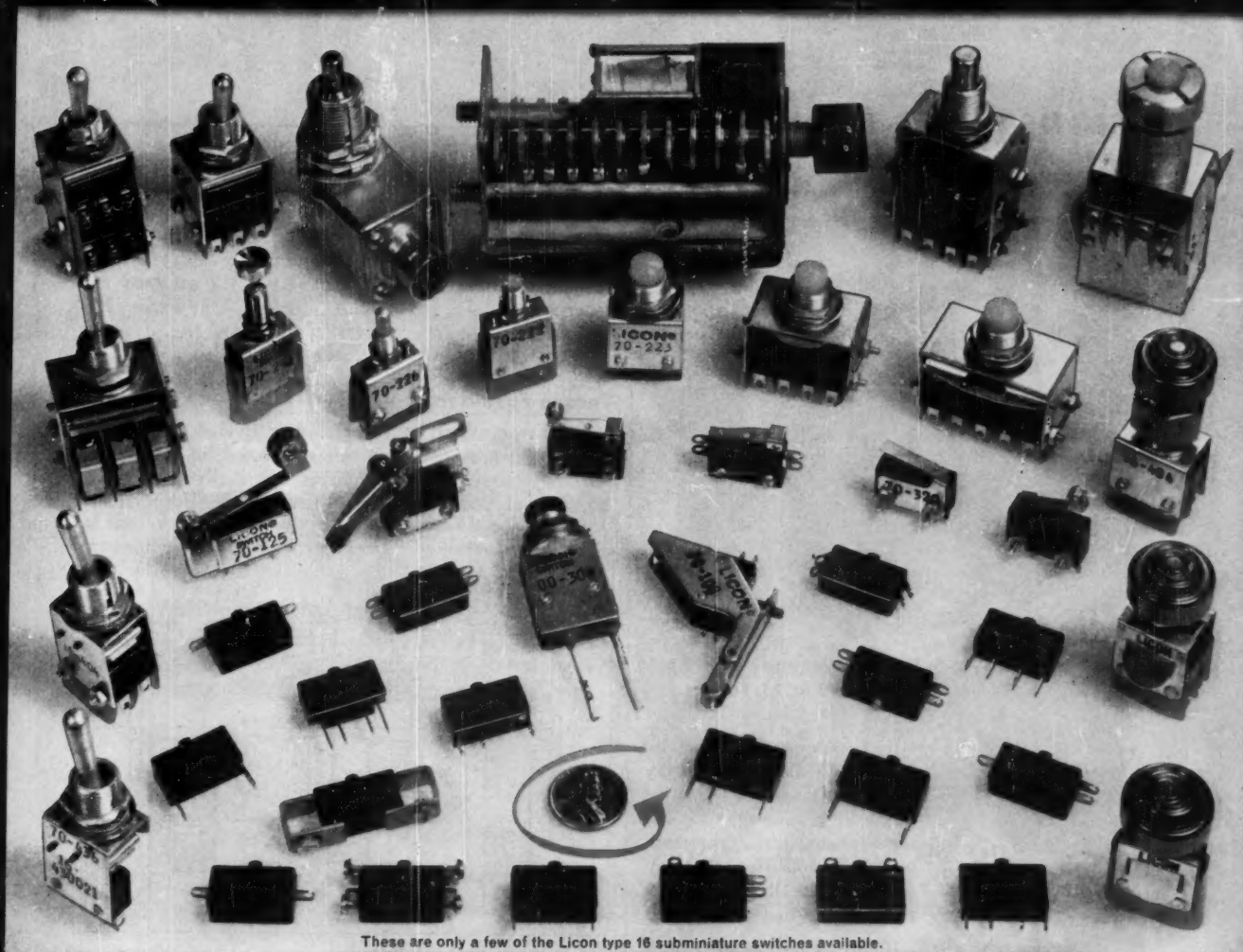
quickly to the electrode immersion cavity. As a result of this "flowback" action, the mercury level at the center of the switch is maintained and the circuit is kept closed even under conditions of sustained overload. Patent 2,935,587 assigned to the Adlake Co. by Ross B. Kinkaide.

Low-Speed Positive-Displacement Pump

Little or no fluid slippage in a reversible multiple-cylinder pump is achieved by having one piston serve as a valve for another. Four radial pistons are posi-



tioned at 90 deg intervals. Movement of each piston toward the pump axis for the suction phase is produced by a compression spring. Outward movement of each piston for the discharge phase is produced by a crankshaft and cam arrangement. In the suction phase,



These are only a few of the Licon type 16 subminiature switches available.



LICON®

TYPE 16 SUBMINIATURE SWITCHES

PROVED BETTER 3 WAYS

LONGER LIFE . . . No other subminiature switch can equal the performance and long service life of the Licon Type 16. Only $\frac{1}{8}$ " thick and $\frac{25}{32}$ " long, the Licon Type 16 delivers over 20,000,000 operational cycles without mechanical failure. This has been repeatedly test-proved. Quality and uniform dependability make the Type 16 superior to any subminiature switch.

HIGHEST ELECTRICAL RATING . . . The tiny Type 16 is rated at 10 Amps, 30 volts d-c inductive. This rating, the highest among subminiatures, is achieved with a unique double-break mechanism that effectively increases electrical performance, and life, as well as capacity. Arc energy and heat dissipation are distributed over two places, mini-

mizing the possibility of contact weld. Double-break design offers multiple circuit possibilities not available in other subminiatures. The Licon Type 16 finds wide acceptance in aircraft and missile applications yet is economically adapted to industrial use. Its rating, dependability and performance equal those of a big switch, but its compact size makes it an excellent choice for use where critical space and weight limitations exist.

VERSATILITY . . . Type 16 switches come in reset, momentary, and specially engineered styles. Leaf spring, lever, roller, plunger or combination actuators are standard. Terminals may be solder, screw, or taper tab and may extend from the bottom, sides, or ends of the switch case. Variations of the Type 16 will be engineered to your specification.



THIS CATALOG IS YOURS on request.
It gives dimensional data and engineering "specs"
on the Type 16 and the whole broad Licon line.
Send for yours today.

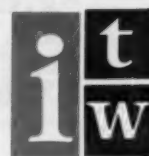
* TYPICAL PROVED APPLICATIONS . . .

Licon Type 16 subminiature switches are presently in use in missile detonators, sensing devices on automatic machine tools, automatic postal equipment, speed control devices, communication equipment, coin changer equipment, automatic door openers, relay actuation, and a host of airborne controls, including hermetic and environment-free units.

Licon

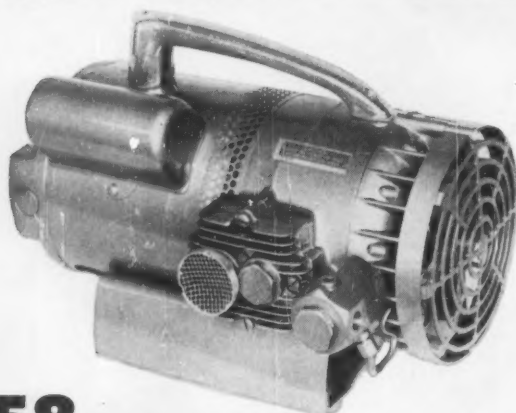
Standard Type 16 Switches and Actuators are available through your local Licon distributor.

DIVISION OF ILLINOIS TOOL WORKS
6606 W. Dakin Street, Chicago 34, Illinois

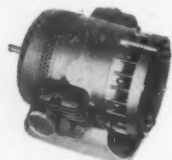


Circle 564 on Page 19

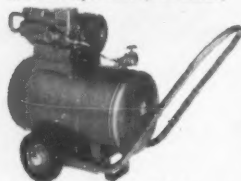
DESIGNERS ARE LEANING TO B&G® Oil-less COMPRESSED AIR TO DO MORE JOBS BETTER



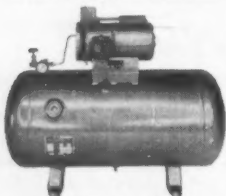
58 MODELS— $\frac{1}{4}$ to $1\frac{1}{2}$ HP—Pressures: to 190 psi.
Vacuum: 27.5"—Air displacement: to 13.14 CFM.



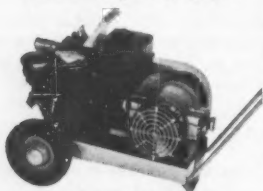
Bare compressor (less motor)



10 gallon Air Tank
Motor Compressor Outfits



30 gallon Air Tank
Motor Compressor Outfits



Gasoline Engine Driven
Compressor Outfits

Use of compressed air is rapidly increasing because of its many exclusive advantages as motive power, for process agitation and for energizing intricate mechanical movements. B&G Air Compressors fit ideally into this picture because they are oil-less!

There is no chance of oil-spoiled work—not a drop of oil can be found in this compact, lightweight compressor. Motor and compressor are permanently grease-packed...carbon-graphite piston rings and skirts operate for years without injury to the cylinder walls. Since the cylinders are not oil lubricated, air is always oil-free—no oil separator needed—no costly lubrication maintenance.

B&G oil-less Compressors are velvet-smooth! Modern design, large bores, short stroke, horizontally opposed pistons provide better balance and vibrationless operation. B&G Compressors are available in a complete line of portable, tank mounted, tankless and gasoline engine driven models.

Send for Catalog GO-259



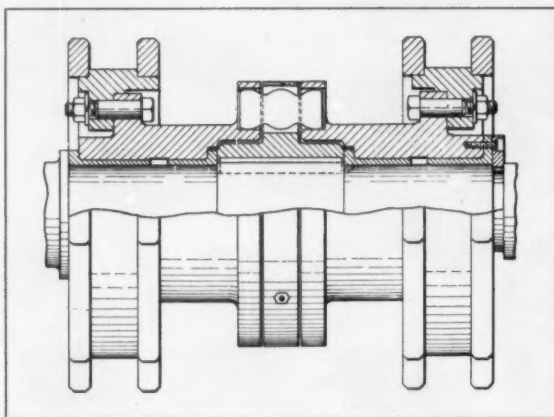
**Oil-less
AIR COMPRESSORS**
BELL & GOSSETT COMPANY
Dept. GF-67, Morton Grove, Illinois

NOTEWORTHY PATENTS

a chamber at the piston head-end fills with liquid that enters through a tube from the mid-zone of the piston immediately ahead. In the discharge phase, fluid flows through the same tube in the opposite direction. The mid-zone of each piston alternately uncovers intake and exhaust ports. Patent 2,931,312 assigned to International Harvester Co., Chicago, by Verne P. Donner.

Torque Equalizer

Load transmitted by two chains is divided equally by differential pins seated in holes in three flanges. The surface contour of each pin is essentially the combination of portions of three spheres. Each spherical

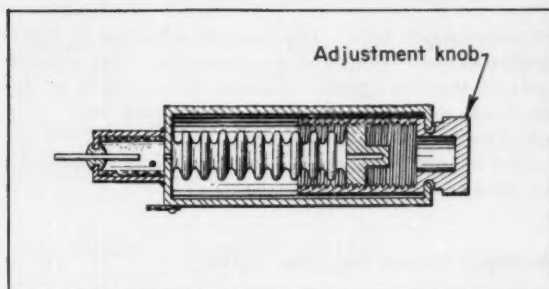


portion of a pin contacts the holes in the three flanges in the manner of a ball. The relative angular motion of the flanges permitted by the pins equalizes the tension forces in the chains. Patent 2,932,381 assigned to Morgan Construction Co., Worcester, Mass. by Roger Kinnicutt Jr. and William J. Hill.

Anchor for two nested coil springs in tension employs two adapters and a fastener member in the shape of an elongated chain link. One adapter has a cylindrical body that fits inside the smaller spring and is nearly the same length. An enlarged portion at one end is recessed and threaded to engage the end coil of the smaller spring. The fastener loop is mounted to this adapter and serves as the anchor for the assembly. The second adapter screws into the end coils of the larger spring, and butts against the enlarged portion of the inside adapter under tension. Patent 2,934,336 assigned to Caterpillar Tractor Co., Peoria, Ill. by Woodrow P. Kimsey and William L. Holmstrom.

Adjustable Constant-Current Device

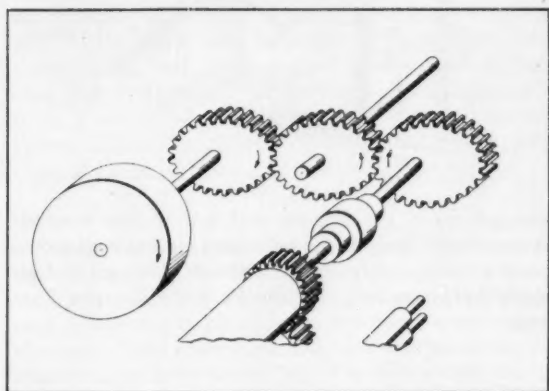
Signal current output, on the order of 10^{-10} amp, is maintained at a constant value within close limits by a compound of radium in a gas-filled chamber. Current variation of less than 0.1 per cent is provided over a range of applied voltage from 20 to 400 volts for any ionizing pressure. The pressure can be varied



by a bellows arrangement which is housed in a chamber under pressure slightly above atmosphere. A certain current output is obtained by changing the pressure of the ionized gas inside the bellows. *Patent 2,934,664 assigned to Tung-Sol Electric Inc. by John F. Grimm.*

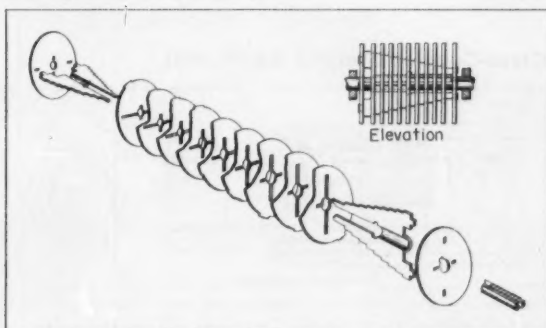
Cyclic Torque-Balancing Drive

Restoration of flywheel inertia as an increasing torque in an assembly of cyclically rotating elements is achieved by noncircular gears. The gear velocity ratios



are so proportioned that when the flywheel decelerates the effective drive ratio is increased to step up the torque delivered at the load point. *Patent 2,933,940 assigned to the Hallden Machine Co., Thomaston, Conn. by Karl W. Hallden.*

Multiple-Disc Assembly



Several discs, such as cams on timer switches, are spaced and locked in position angularly and axially



BUFFALO "Packaged" BELTED VENT SETS

**You can depend on
these Quality Fans for**

- ▶ **RATED OPERATION**
- ▶ **LOW NOISE LEVEL**
- ▶ **MINIMUM VIBRATION**
- ▶ **TROUBLE-FREE OPERATION**

Highly efficient, quiet, compact units. Ruggedly built, yet light in weight. Easy to install, indoors or outdoors. (Available with all-weather drive covers). Buffalo design assures minimum turbulence, prevents overloading. Variable capacity provides for future increased ventilation needs. Capacity range: 500 to 20,000 CFM. Write for Bulletin 3720-A.

For full details on Buffalo Air Handling Equipment and Centrifugal Pumps, contact your nearby Buffalo Representative or write direct.

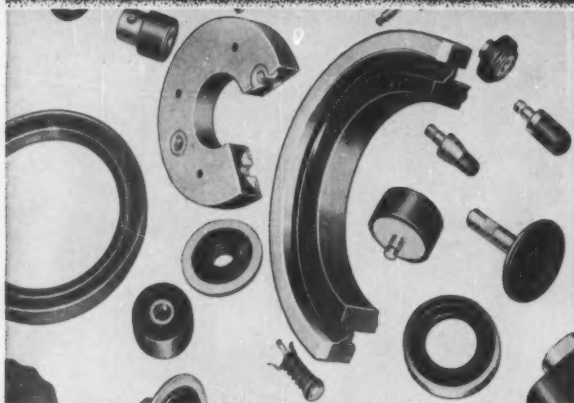


BUFFALO FORGE COMPANY
Buffalo, N. Y.

Buffalo Pumps Division Buffalo, N. Y.
Canadian Blower & Forge Co., Ltd., Kitchener, Ont.

**VENTILATING • AIR CLEANING • AIR TEMPERING
INDUCED DRAFT • EXHAUSTING • FORCED DRAFT
COOLING • HEATING • PRESSURE BLOWING**

have a **BONDED to METAL** problem?



FOR
CUSTOM
COMPOUNDED
PRECISION
FABRICATED

Go Goshen RUBBER

BONDED
TO
METAL
PRODUCTS

The unique GORBOND process developed by Goshen Rubber permits parts fabricated from natural, synthetic and silicone rubbers, to be bonded to metal, plastics and most anything . . . to meet customer satisfaction. Facilities are complete and modern, for efficiently handling large and small quantities.



On your very next bonding problem, call in the specialist from Goshen.

Goshen Rubber Co., Inc.

1760 S. TENTH ST.

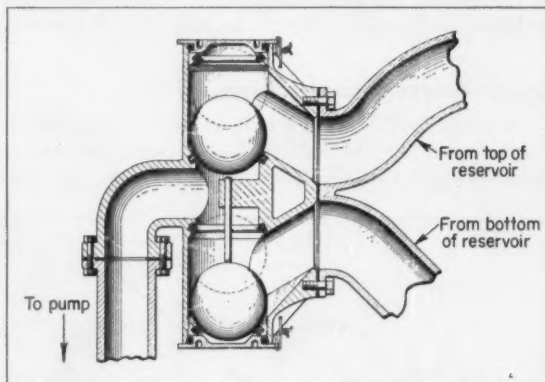
GOSHEN, INDIANA

NOTEWORTHY PATENTS

by two stepped keys. The keys are mounted at right-angles to each other, and are assembled from opposite ends of the disc "pack." Crossed slots in each of the discs are proportioned to fit the stepped keys at a specific position along the shaft. *Patent 2,932,983 assigned to General Motors Corp., Detroit, by Donald W. Laviana and Ralph D. Unterborn.*

Multiple-Source Selector Valve

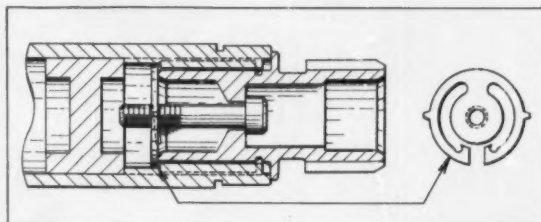
Gravity adjustment of a valve to draw fluid from the downward side of a reservoir, regardless of its orientation in space, is provided by two balls that seat against O-rings. The balls move under gravity to open or close



passages from the bottom and top of the reservoir. A spacer pin prevents the balls from closing both suction ports simultaneously. *Patent 2,933,095 assigned to Hou-daille Industries Inc., Buffalo, by Rollin Douglas Rumsey.*

Overdrive transmission utilizes planetary gearing to step up drive ratio when a predetermined speed is reached. Operation of the planetary gear set is controlled normally by a governor which automatically locks the sun gear at the change over speed. A manual over ride permits the operator to disengage the planetary gear set at any time, returning the transmission to direct-drive operation. *Patent 2,933,944 assigned to Borg-Warner Corp., Chicago, by Harold E. Carnagua.*

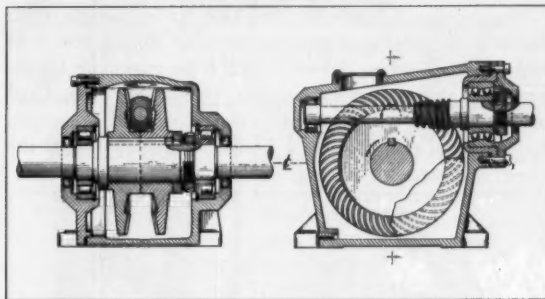
Close-Coupled Flexible Shaft-Joint



Positive and resilient connection of two loosely-splined, power-transmitting, shaft ends is provided by a washer-like metal disc. The disc is mounted in a

counterbored section of the larger shaft like a retaining ring. A bolt connects the smaller shaft to the center of the disc. The disc serves as a resilient member and distorts to accommodate misalignment between shafts. Patent 2,934,919 assigned to Vickers Inc., Detroit, by James Barta and Edward F. McEntee.

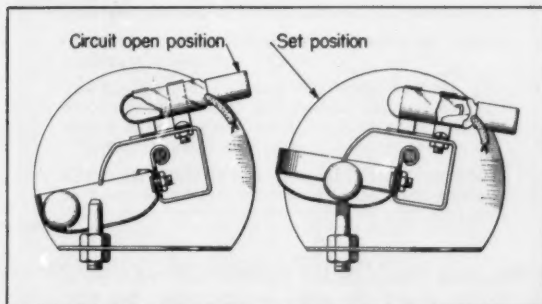
High-Capacity Reduction Gearing



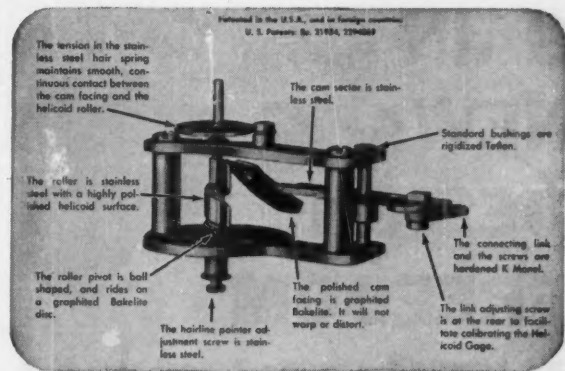
A single worm or pinion meshing with two gears on opposite sides nearly doubles the torque output of the driven shaft and substantially eliminates axial thrust loads. Both gears are keyed to the same shaft. One gear is essentially the reverse of the other. The drive is suited only to high ratios of 40:1 and greater. Patent 2,935,885 assigned to Illinois Tool Works, Chicago, by Oliver E. Saari.

Temperature-compensating strain gage incorporates a thermocouple in the electrical circuit to eliminate inaccuracies caused by temperature changes. The thermocouple junction is placed near the strain-gage sensing element. The strain-gage and the thermocouple are connected in series in one leg of a Wheatstone bridge. The thermocouple output is connected into the bridge circuit so that its current flow opposes that of the strain-gage. Patent 2,930,224 assigned to Lockheed Aircraft Corp., Burbank, Calif. by Martin Bodner and Ward B. Brewer.

Vibration Responsive Switch



Abnormal vibration and shock loads in an electrical switch assembly are sensed by a ball mounted on a pedestal. Displacement of the ball into a receptacle changes the angular position of the receptacle and of a



Exclusive Helicoid movement provides Sustained Accuracy ...on the toughest jobs!

• Helicoid Gages have no gears, no teeth—wear is reduced to an absolute minimum. No danger of fouling, either—rolling action of cam facing keeps contact surface clean. Even when subjected to violent pressure pulsations or mechanical vibrations, Helicoid Gages stay accurate. Only Helicoid Gages provide all these advantages:

Sustained accuracy—Helicoid movements have been tested through 75,000,000 cycles, with virtually no wear or loss of accuracy. Conventional geared gages on the same test became useless after only 500,000 cycles.

Durability—Bourdon tubes won't stretch, leak or crack. Dial faces won't corrode or chip.

Wide selection—Gages are available for practically any application from tap water to acid. Gages include flanged and flangeless, round and square, in standard and flush-mounting models. Accessory equipment includes gage cocks, needle valves, siphons and snubbers.

NEW! Solid-Front Safe-T-Case Gage

This new Helicoid design diverts the force of a burst in a backward direction, away from the operator. The force escapes by deforming the back cover plate, which can then be replaced inexpensively.



Write for Catalog DH-65 for details on the complete line of Helicoid Gages

Distributed in Canada by Upton, Bradeen & James, Ltd.
Quebec, Montreal, Ottawa, Toronto, Hamilton, Windsor, Winnipeg, Edmonton, Vancouver

HELICOID GAGES

Helicoid Gage Division • American Chain & Cable Company, Inc.
929-M Connecticut Ave., Bridgeport 2, Conn.

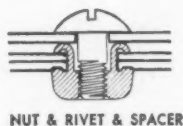
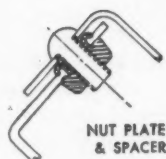


GAIN NEW DESIGN FREEDOM WITH TRS Perma-Nuts®

You can have your cake and eat it too — if you use Perma-Nuts in your assembly designs. With these unique TRS fasteners, you keep all the advantages of threaded attachments, and gain all the simplicity, speed and economy of automatic riveting.

Here are just a few of the many fastening spots where a Perma-Nut does the job best. Each Perma-Nut has from 3 to 4½ clean threads, entirely within the head thickness, to give it ample screw-holding strength. Serrations under the head bite into the surface when the fastener is set, acting as a built-in lockwasher to prevent turning. The head itself takes no more room than a standard hex nut of the same thread size. Nine thread sizes are available, from #3-48 to ¼-28, in steel, brass or aluminum.

In many cases, actual product design improvements have resulted from imaginative use of these cost-cutting fasteners. Your TRS man has worlds of experience in their use. Find him in the "Yellow Pages" — or write us direct, for fast, efficient, economical help.



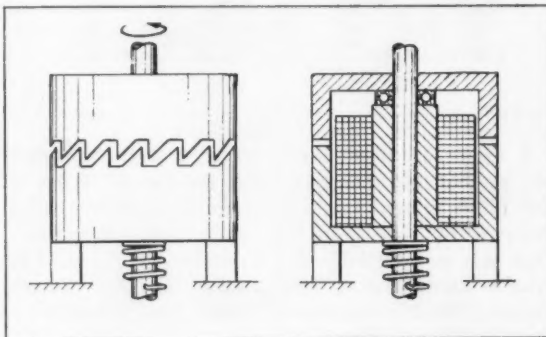
TRS TUBULAR RIVET & STUD
COMPANY
QUINCY 70, MASSACHUSETTS

NOTEWORTHY PATENTS

mercury switch supported upon a common pivot. When the mercury switch tilts, it breaks an electric circuit, serving as a signal source for other operations. The switch is reset manually. *Patent 2,927,982 assigned to George Windeler Co. Ltd., San Francisco, by Jack M. Slough.*

Rotary Magnetic Actuator

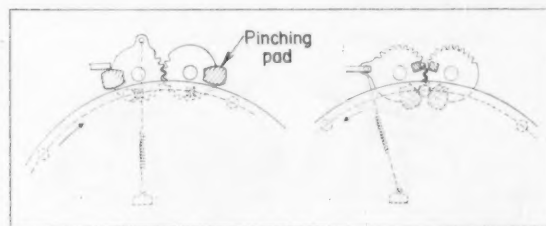
Parallel tooth surfaces, inclined at an angle with the axis of rotation, produce angular displacement of two cylinders when drawn together by magnetic forces. The actuator assembly consists essentially of a fixed pole piece and a mating movable cylindrical armature. An electrical coil sets up a magnetic field between the



teeth on the two elements. The teeth on the armature move both axially and circumferentially to engage the pole piece. A torsion and compression spring restores the armature to the initial position when the coil is de-energized. *Patent 2,934,680 assigned to North Atlantic Industries Inc., Westbury, N. Y., by Arthur J. Buchtenkirch.*

Precise Positioning Detent Mechanism

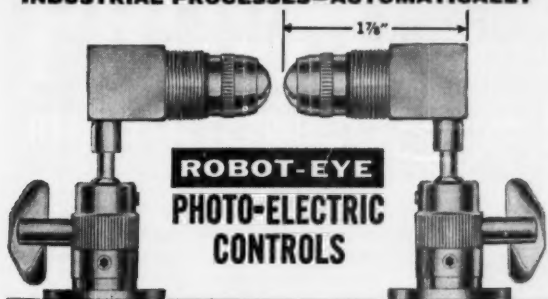
Angular movement of a disc in either direction is positioned by dual gear-like pawls. One pawl is spring loaded. When the spring is on one side of dead center, it keeps two pinching pads, one on each pawl, clear of



a disc stop pin. On the opposite side of dead center, the spring causes the pads to pinch the stop pin firmly from both sides. The dual pawl device is adaptable to a slide for linear motion as well as to a disc of any size. *Patent 2,932,980 assigned to Allen B. Du Mont Laboratories Inc., Clifton, N. J., by Clifford Dale Nestlerode and David Coan Felt.*

count, inspect, control

INDUSTRIAL PROCESSES—AUTOMATICALLY



**ROBOT-EYE
PHOTO-ELECTRIC
CONTROLS**

**Transistorized and Tube
AMPLIFIERS**



Plug-in relays, receptacles for plug-in connection of lamps and cells. Additional Plug-in accessories include counters and time delays.

MINIATURIZED

Small, for "tight-spot" installation, yet rugged for long service. Accurate, for precise automatic control in virtually any industry.

INTER-CONNECTING

Plug-in terminals available for quick connection to any of a wide range of Amplifiers. This design enables you to select the most economical amplifier for your job requirements.

INEXPENSIVE

Standard Set P-5 is \$17. Set P-5S is \$21. Amplifiers start at \$39.50. For complete data, write for Brochure MP-6.

standard INSTRUMENT CORPORATION

657 BROADWAY, NEW YORK 12, N.Y.

in Canada: STANDARD INSTRUMENTS (CANADA) LTD.
767 Warden Ave., Scarborough • Toronto, Ontario

Circle 570 on Page 19

Lexington Controls announces

WORLD'S MOST ACCURATE AIR-PRESSURE REGULATOR

- Holds pressure to 1/5 of 1/10 of 1% of its range over substantial variations in supply pressure, flow, and ambient temperature. Resolution: 1 part in 10,000 of range.
- No exhaust-valve "pick-up" or initial drop-off on dead-end service. No drift with time or periodic shutdown.
- Designed for rugged service and minimum maintenance.
- 50,000 user-tested for 6 years. Accepted as primary standard of reference.



You can prove it! This new air pressure regulator is the world's most accurate and reliable device for precise control of air or gas pressure. Yet it costs no more than other pilot-operated regulators.

Key to its unequalled accuracy and instant response is its patented high-gain servo design, which uses regulated rather than supply pressure, and its stainless steel pressure capsule

Available in 2-25, 3-60, or 3-120 psi ranges for 1/4", 1/2", or 3/4" NPT pipe at 15 U.S. stocking points. Standard trade and quantity discounts. Write now for data sheet and prices.

Lexington Controls
INCORPORATED®

P. O. BOX 132-B BURLINGTON, MASS.

PROTECTED BY U.S. AND FOREIGN PATENTS AND PATENTS PENDING.

Circle 571 on Page 19

new airmatic Air-Operated "C" Clamp



SIMPLIFY CLAMPING JOBS —SPEED PRODUCTION

You'll get the right amount of pressure, every time, whatever the clamping operation—with this new Airmatic Air-Operated "C" Clamp. And you'll find dozens of applications in every department of your plant or shop—for this and the many other Airmatic Clamping Cylinders—that assure accuracy and speed production.

Our quality is tops. Our deliveries are prompt. Our prices are right. Our engineering services are yours for the asking.

Write for our latest catalog CC-3000

AX-26

AIRMATIC

VALVE, INC.

7313
Associate Ave.,
Cleveland 9, Ohio

Phone: WUdoline 1-5370 • WESTERN UNION: Airmatic Valve Inc. FAX: Cleveland, Ohio

Circle 572 on Page 19

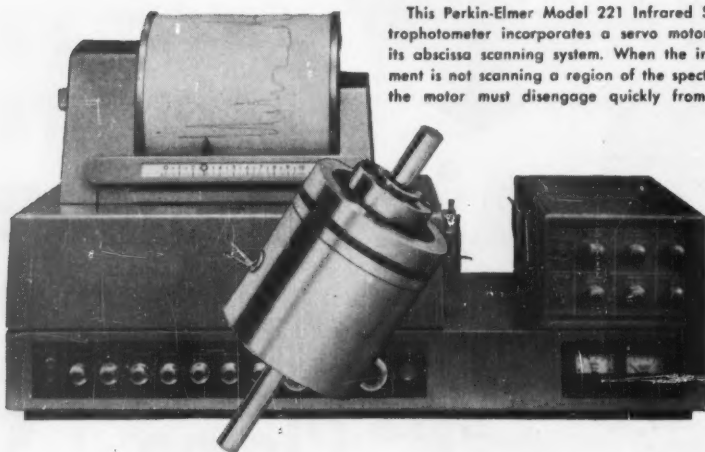
253

PERKIN-ELMER specifies



ELECTRIC CLUTCHES

for Small Size . . . High Torque Transmission . . . Quality at Low Cost



This Perkin-Elmer Model 221 Infrared Spectrophotometer incorporates a servo motor for its abscissa scanning system. When the instrument is not scanning a region of the spectrum, the motor must disengage quickly from the

Littrow mirror drive and recorder system in order to allow the fastest possible abscissa run-back.

Perkin-Elmer chose a SIMPLATROL (Fixed Field) Clutch for this highly critical automatic function. Says Perkin-Elmer, "The Simplatrol Clutch is well suited for this application because it combines small size and high torque transmission with high quality at moderate cost."

Applications such as this are typical of the wide range of functions which SIMPLATROL miniature and small and fixed field electric clutches and brakes perform in electronics and automation. Wherever there is a need for accurate and compact clutching or braking, swift, silent Simplatrol assemblies do the job.

The only moving part in the Simplatrol clutch and brake operation is the patented diaphragm. Simplicity is the keynote and the basis of the success of these performance-proved clutches and brakes.

Ask today for SIMPLATROL literature on miniature and small fixed field and larger size electric clutches and brakes. Discover how Simplatrol clutches and brakes can be readily adapted to your own special requirements.



Simplatrol products corp.

24-5 SALISBURY ST., WORCESTER, MASS.

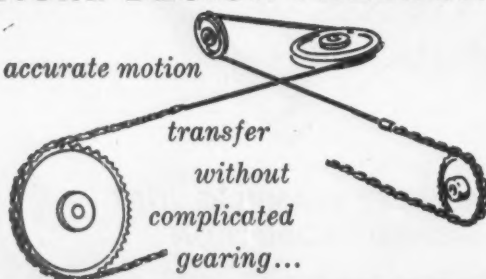
Representation in Key Industrial Areas

5113-9

Circle 573 on Page 19

MORE DESIGN FREEDOM

accurate motion

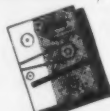


transfer
without
complicated
gearing...

SIERRA MINIATURE MECHANICAL CHAIN AND SPROCKETS...

Provide precise, positive motion transfer through several planes simultaneously with no cable slippage...no complicated gearing. Unlimited center-to-center selection for miniature and sub-miniature assemblies in servo systems, gyro systems, special cameras, electronic equipment, and small precision instruments. Less weight, cost, maintenance—wider tolerances. Designed to operate around minimum 7-tooth sprocket with root diameter of .250 inches. Chain pitch .1475 inches; Weight .45 oz. per lineal ft. Material: stainless steel, or other materials.

NEW CATALOG



Contains useful application data, specifications, tables on chain pitch and sprocket sizes, suggestions for calculating center-to-center distance. Write for yours today.

123 E. Montecito Avenue,
Sierra Madre, California



T. M. REG.

254

Circle 574 on Page 19

GEARS

SPUR and HELICAL

to Your Specifications

Red Ring
Quality and Precision

- Experimental Units
- Pilot Runs
- Moderate Production

SPUR AND HELICAL GEAR SPECIALISTS
BROUGHTERS OF ROTARY SHAPING
AND ELLIPTICAL TOOTH FORM

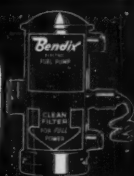
Ask for Bulletin GL-1 A

NATIONAL BROACH & MACHINE CO.

5600 St. Jean • Detroit 13, Michigan

Circle 575 on Page 19

PROVED



BENDIX ELECTRIC FUEL PUMP

CONSTRUCTION EQUIPMENT • TRACTORS • BUSES
SHOP TRUCKS • CARS • TRUCKS • EARTH MOVERS
FIRE ENGINES • BOATS • TANKS • PLANES • HEATERS
AGRICULTURAL EQUIPMENT • GENERATOR SETS

Bendix* Electric Fuel Pumps deliver outstanding, dependable performance—proved in temperatures from -76° to $+114^{\circ}$. Easily installed and serviced. Built-in pressure release. Delivers more gallons per hour. *Positively prevents vapor lock.* Write for descriptive folder and specifications.

*REG. U.S. PAT. OFF.

Bendix-Elmira

Eclipse Machine Division
Elmira, New York



Circle 576 on Page 19



On the left, a conventional metallic fastener. On the right, a Nylogrip nylon fastener. The big difference: Nylogrip is an excellent insulator, eliminates need for collars and washers. Nylogrip is corrosion and chemical resistant. Nylogrip is self-locking, eliminates need for locking devices. Nylogrip is more than 50% lighter, yet has tensile strengths up to 15,700 p.s.i. Nylogrip is available in a full range of colors. Nylogrip is highly heat resistant—form stable up to 450° F, withstands up to 300° F continuous heat with special nylons. Best of all: Nylogrip has largest available stock of non-metallic fasteners. Economical small lot prices, fast delivery. Specials engineered to your requirements. **WRITE FOR DETAILS.**

NYLOGRIP NYLON FASTENERS—
Stocked in most head styles; diameters:
#2 through $\frac{1}{2}$ " ; lengths $\frac{1}{8}$ " through 2"
hex nuts, flat washers, set screws—
threaded rod—lock nuts—nylon balls
—PVC fasteners—Nylogrip Dubo
Lockwashers.



**NYLOGRIP
PRODUCTS**

569 Pleasant St.,
Watertown, Mass.
WALnut 6-0100

Circle 578 on Page 19

Rita Roylyn Says:

RoyLAIR

COUPLINGS ARE
HEAD AND SHOULDERS
ABOVE ALL OTHER
LOW-COST
COUPLINGS"



- HIGH QUALITY
- LOW COST
- IMMEDIATE DELIVERY

Pneumatic Coupling
Series—For shop air line
applications
P T Coupling Series—
For light pneumatic tool
applications



No. 250-2
CONNECTOR
for use with
COUPLING NO. 250



NO. 250
PNEUMATIC COUPLING



No. 254
BLOW GUN for use
with No. 250
PNEUMATIC COUPLING



"THE BEST CONNECTIONS IN THE WORLD"

Write today for your RoyLAIR Catalog to:

AIRATERRA, 620 PAULA AVENUE, GLENDALE 1, CALIFORNIA

Circle 577 on Page 19

Lepel

HIGH FREQUENCY INDUCTION
HEATING EQUIPMENT
For Hardening • Annealing • Soldering
Brazing • Zone Refining • Crystal Growing



ELECTRONIC TUBE GENERATORS:

1 kw; $2\frac{1}{2}$ kw; 5 kw; 10 kw;
20 kw; 30 kw; 50 kw;
75 kw; 100 kw.

SPARK GAP CONVERTERS:

2 kw; 4 kw; $7\frac{1}{2}$ kw;
15 kw; 30 kw.

WRITE FOR THE NEW LEPEL
CATALOG 36 illustrated pages
of valuable information.

**Lepel HIGH FREQUENCY
LABORATORIES, INC.**

55th ST. & 37th AVE., WOODSIDE 77, N. Y.

Circle 579 on Page 19

255

Vote **THE STRAIGHT ECONOMY Ticket!**

JOIN THE CAMPAIGN FOR INCREASED PROFIT!



OUR CANDIDATE

Are your "encumbent" bearings spending more of your profits than necessary? Many so-called "anti-friction" bearings cost more than needed to do the job. *Today* is election day. Switch *now* to the **TRIANGLE PARTY'S** reliable, economical self-aligning sleeve-type pillow blocks... re-elected term-after-term by leading manufacturers.


— **THE TRIANGLE PLATFORM** —

- ✕ **QUALITY IMPROVEMENTS**
- ✕ **COST REDUCTIONS**
- ✕ **SERVICE RELIABILITY**

TRIANGLE MANUFACTURING Co.
736 Division St., Oshkosh, Wis.

Write For free campaign literature on the most complete line of self-aligning sleeve bearings and mountings.

Circle 580 on Page 19



FLOW METERS

FLOW INDICATORS

ROTAMETERS (for measuring fluid rate of flow): General Purpose, Glass Tube; Armored; Bypass and "T" types for large flows; Transmitting for remote indicating, recording, or controlling rate of flow; Laboratory; Chemical; Alarm; and Purge.

FLOW INDICATORS (for visual observation of fluid flow): Flapper; Rotary; and Ball Flow.



NEW BULLETIN M-1 pictures and describes SK's line of Rotameters and Flow Indicators. Copies are available on request.



Schutte and Koerting COMPANY
INSTRUMENT DIVISION

2277 STATE ROAD, CORNWELLS HEIGHTS, BUCKS COUNTY, PA.

Circle 581 on Page 19

Wiley BOOKS

AERO-THERMODYNAMICS AND FLOW IN TURBOMACHINES

By M. H. VAVRA, U. S. Naval Postgraduate School. Gives a good understanding of flow phenomena and shows rational methods for formulating them mathematically. This is done by using a theoretical approach stressing basic physical processes rather than empirical methods. Part I sets up basic flow relations. Part II covers types more closely related to flow in machines, and Part III is concerned directly with flow in machines. A valuable feature is the book's use of vector- and tensor-analysis to establish fundamental flow relations. 1960. 609 pages. \$14.50

THEORY OF MECHANICAL VIBRATION

By KIN N. TONG, Syracuse Univ. Theory-centered rather than problem-centered, this book covers linear theory and its extensions, with up-to-date mathematical methods and techniques. Stresses engineering applications of the theory. 1960. 348 pages. \$9.75

Send now for on-approval copies

JOHN WILEY & SONS, Inc.
440 PARK AVENUE SOUTH, NEW YORK 16, N. Y.

Circle 582 on Page 19

FOR PUBLIC ADDRESS, RADIO, and kindred fields, specify JONES 400 SERIES PLUGS AND SOCKETS of proven quality!



P-406-CCT



S-406-AB

Double-Contact Area
Phosphor bronze knife-switch socket contacts engage both sides of flat plug contacts.

Socket contacts phosphor bronze, cadmium plated. Plug contacts hard brass, cadmium plated. Insulation molded bakelite. Plugs and sockets polarized. Steel caps with baked crackle enamel. 2, 4, 6, 8, 10, 12 contacts. Cap or panel mounting.

Information on complete line, in Jones Catalog 22. Electrical Connecting Devices, Plugs, Sockets, Terminal Strips. Write

HOWARD B. JONES DIVISION
CINCH MANUFACTURING COMPANY
CHICAGO 24, ILLINOIS
DIVISION OF UNITED CARR FASTENER CORP.

Circle 583 on Page 19

Interchangeable QUICK DISCONNECTS AIR GASES LIQUIDS

connect or disconnect the
fastest and easiest way

Just plug in . . . the patented PUSH-O-MATIC locking mechanism automatically forms a positive, leak-proof connection . . . no turning or twisting necessary. Connect to most sockets and plugs regardless of make . . . because the **Series D is interchangeable** . . . interchangeability saves valuable set-up time and reduces costly coupling inventories.

Integral shut-off valve provides fast connection on production set-ups—one hand operation permits easy connect or disconnecting. **360° swivel action** reduces operator fatigue and eliminates hose kinking.

The Series D interchangeable coupling can be used on air, gases, or liquid lines which makes it ideal for most all industrial uses. Maximum flow with minimum pressure drop. The performance and construction Military Specifications MIL-C-4109-A.

Available in 4 types of end connections and sizes 1/8" through 3/4" NPT. Maximum pressures to 7,500 PSI connected.

Write for Bulletin 1500—compare high flow characteristics.

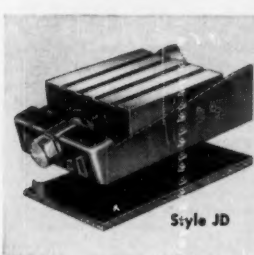
PERFECTING SERVICE CO.
334 Atando Ave. Charlotte, N. C.

Baltimore—Buffalo—Cape Can, N. J.—Chicago—Cleveland—Los Angeles—New York—Providence—Hamilton, Ont.—Montreal—Toronto



Circle 584 on Page 19

DEPENDABLE MACHINE SUPPORT!



Style JD



Style JS

With

EMPCO

LEVELING JACKS

For better machine performance set your machines level and keep them level! That's the key to increased production with less maintenance! EMPCO Leveling Jacks provide a solid, adjustable support for machine tools, large surface plates, tool room, and production equipment of all types. Easily installed and located, EMPCO Jacks keep your equipment level and

stable—keep maintenance at a minimum.

VI-SORB Mounting Pads, optional with EMPCO Jacks, control vibration from within the machine itself and reduce transmitted vibrations. Available in six styles and 25 models there's a EMPCO Jack and VI-SORB Mounting Pad for your every machine leveling requirement!

WRITE TODAY FOR ILLUSTRATED BULLETIN AND PRICES!

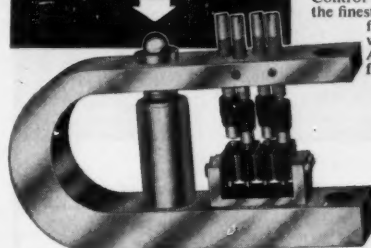


THE ENTERPRISE MACHINE PARTS CORPORATION
2734 JEROME AVENUE • DETROIT 12, MICHIGAN

Circle 586 on Page 19

now control mechanical forces at various load points

Dillon force control switch



Here's a compact instrument that enables you to control motors, light remote control signals or operate warning devices with split-hair accuracy . . . automatically! Available in TENSILE or COMPRESSION, the Dillon Force Control Switch is furnished with from 1 to 4 adjustable switches for controlling forces at countless load points. Capacities range from 0-100 lbs (for delicate loads) to 0-50,000 lbs (for most massive loads). Protected against accidental overloading, the Dillon Force Control Switch is constructed of the finest tempered steel and will flex millions of cycles without losing resiliency. An ideal safety device for overhead hoists!

6 different ranges

FC577



WRITE FOR FREE ILLUSTRATED LITERATURE AND LOW PRICE SCHEDULE.

W. C.

Dillon

& COMPANY, INC.
14564 Keswick St.
Van Nuys 11, Calif.

Circle 585 on Page 19

New Metron Anti-Backlash Speed Reducers

Small in size
Ready-to-go
in your product
Quick delivery

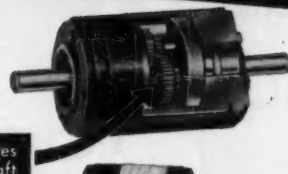
• Backlash only 15 minutes or less at lowspeed shaft

- Speeds up to 10,000 rpm at highspeed shaft
- Up to .013 HP at lowspeed shaft

Save on your design, production, and assembly costs by ordering these ready-to-go miniature components for your product.

ONE WEEK DELIVERY

WRITE
for Bulletin
97



CLASS A—
34 ratios
up to
27 to 1



CLASS B—
49 ratios
up to
729 to 1



CLASS C—
122 ratios
up to
19,683 to 1

CLASS D—232 ratios up to 531,441 to 1 (not shown)

INSTRUMENT COMPANY

Metron

442 Lincoln St., Denver 3, Colo.

• NEW YORK • CHICAGO • DETROIT •
• LOS ANGELES • CLEVELAND •

Circle 587 on Page 19

257

The Most Compact Solenoid
Valve in the Fluid
Power Control Field...

VERSA SERIES "A"



Versa's new four-way solenoid valves measure only 5 1/2" high by 1 1/2" diameter, yet have a full 3/16" diameter flow area. Completely corrosion-resistant and simple to install, Versa Series "A" solenoid valves are available in over 100 different variations. Triple pressure and functionally tested under water for guaranteed leakproofness.

VERSA

VERSA PRODUCTS COMPANY INC.
150 M. COOLIDGE AVENUE
ENGLEWOOD, NEW JERSEY



Write today for
your free copy of
Bulletin #1259

Circle 588 on Page 19

Is one of
these
Drive
Problems
YOURS



- ✓ Smoother
- ✓ High-Inertia Starts
- ✓ Excessive Loads
- ✓ Controlled Acceleration
- ✓ Dynamic Braking
- ✓ Partial or
- ✓ Full Stall

You need
GLEASON-

TORMAG®

Magnetic DRIVES

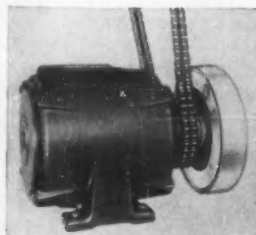


Here's dependable drive protection that can save you money. The new GLEASON-TORMAG Magnetic Drive on your equipment provides frictionless, shockless drive, dependable controlled torque, high slip or continuous stall operation, smoother cushioned starts, . . . a combination of advantages achieved in no other type of drive. Uniquely simple in design and construction, operating through eddy currents developed by permanent magnets, GLEASON-TORMAG Drive delivers high efficiency at rated horsepower under

full operating loads. No power loss in fluids, or particles or in mechanical friction. Can be used as an "in line" or "take off" drive with flexible couplings, chains, sprockets, belts. Standard sizes range from 1 to 10 H.P., at 1750 RPM. Also Custom-engineered in fractional, and up to 30 H.P. Write on Company Letterhead for new catalog No. TP160.

TORMAG DIVISION
GLEASON REEL CORP.

740 N. Plankinton Ave., Milw. 3, Wis.
Representatives in Principal Cities
in U.S. and Canada.



Circle 589 on Page 19

ENGINEERS AVAILABLE OR WANTED

AVAILABLE: Design Engineer for board work. Offering you competence, ability and twenty years' experience on design of product, power press dies, automatic and other machinery, production tools; quality draftsmanship; ingenuity and originality on development of ideas. Temporary engagements or projects. Fee basis. Any location. Address: Boxholder, 202 Back Bay Postal Annex, Boston, Massachusetts.

WANTED: Mechanical Design Engineers—B.S.M.E. degree. Minimum of 2 1/2 years experience in machine or equipment design. Prefer varied design experience with emphasis on production machinery and tool design. Outstanding, rapid-growing company in field of solid propellants located in East Texas. Send detailed resume to: Personnel Department, Thiokol Chemical Corporation, Marshall, Texas.

WANTED: PRODUCT DESIGNERS. The expansion of our new product program has created outstanding opportunities for experienced designers to work with our new product development group, creating exciting new photographic products for our nationally known consumer goods line. Previous design experience in electro-mechanical devices or small precision parts will further qualify applicants for these positions. Excellent working conditions and benefits combined with a truly professional atmosphere is only part of the argus picture. Direct resume or letter to Employment Manager, ARGUS CAMERAS, Ann Arbor, Michigan.

WANTED: CHIEF MECHANICAL ENGINEER. The man we want must be a seasoned professional engineer with creative experience in designing highly automated machines for the assembly of small components. He will have directed machine shop and plant maintenance operations. Successful candidate will have an M.E. degree. He will be between 34 and 45 years of age, and will have a minimum of 5 years' experience as a senior machine design engineer. Well-established company in western suburb of Chicago with very fine growth history and potential. Excellent salary and bonus. Send complete resume to Box 973, MACHINE DESIGN, Penton Bldg., Cleveland 13, Ohio.

Advertising Index

Airterra	255
Airmatic Valve, Inc.	253
Airpax Electronics, Seminole Division	201
Alco Products, Inc.	222
Allegheny Ludlum Steel Corporation	109
Allen-Bradley Co.	207
Allis-Chalmers, Industrial Equipment Division	29
Allis, Louis, Co., The	74, 75, 76, 77
Aluminum Company of America	211
American Brake Shoe Co., Denison Engineering Division	93
American Brass Co., The	5
American Chain & Cable Co., Inc., Helicoid Gage Division	251
American Machine and Metals, Inc., Hunter Spring Co. Division	63, 64
American Machine and Metals, Inc., The Lamb Electric Co. Division	116
Apex Machine & Tool Co., The	197
Associated Spring Corporation	111
Associated Spring of Puerto Rico, Inc.	111
Automatic Electric	72
Automotive Gear Division, Eaton Manufacturing Co.	16

Barksdale Valves, Control Valve Division	246
Barnes, Wallace, Co., The, Ltd., Division of Associated Spring Corporation	111
Barnes, Wallace, Division, Associated Spring Corporation	111
Barnes, Wallace, Steel Division, Associated Spring Corporation	111
Bearings Company of America, Division of Federal-Mogul-Bower Bearings, Inc.	171
Bell & Gossett Co.	248
Bellofram Corporation	179
Bellows Co., The, Division of International Basic Economy Corporation	186
Bendix Corporation, The, Eclipse Machine Division	255
Benton Harbor Engineering Works, Inc.	198
Bethlehem Steel Co.	105
B-G-R Division, Associated Spring Corporation	111
Boehme, H. O., Inc.	261
Borg-Warner Corporation, Rockford Clutch Division	221
Bound Brook Oil-less Bearing Co.	Inside Front Cover
Bower Roller Bearing Division, Federal-Mogul-Bower Bearings, Inc.	53
Brown & Sharpe Mfg. Co., Hydraulics Division	194
Bruning, Charles, Co., Inc.	33
Buffalo Forge Co., Buffalo Pumps Division	249

Chain Belt Co.	185, 187, 189, 191
Chikson Co.	65
Cinch Manufacturing Co., Howard B. Jones Division	256
Cleveland Worm & Gear Division, Eator Manufacturing Co.	Inside Back Cover
Colorado Oil and Gas Corporation, Marsh Instrument Co. Division	210
Commercial Shearing & Stamping Co.	100
Controls Company of America, Control Switch Division	182, 183
Conway Clutch Co., The	212
Cramer Controls Corporation	54
Crane Packing Co.	27
Cutter-Hammer, Inc.	Back Cover

Dana Corporation	114
Denison Engineering Division, American Brake Shoe Co.	93
Diamond Chain Co., Inc.	227
Dillon, W. C., & Co., Inc.	257
Dixon Corporation	176
Dow Corning Corporation	55, 56
Dunbar Brothers Division, Associated Spring Corporation	111
Du Pont, E. I., de Nemours & Co., Inc.	68, 69
Durez Plastics Division, Hooker Chemical Corporation	243
Dynatomic Division, Eaton Manufacturing Co.	173
Eagle Signal Co.	214
Eastman Chemical Products, Inc.	206
Eastman Manufacturing Co.	58

Eaton Manufacturing Co., Automotive Gear Division	16
Eaton Manufacturing Co., Cleveland Worm & Gear Division	Inside Back Cover
Eaton Manufacturing Co., Dynatomic Division	173
Eclipse Machine Division, The Bendix Corporation	255
Electro Devices, Inc., Servospeed Division	224
Elgin National Watch Co., Abrasives Division	202
Enterprise Machine Parts Corporation	257

Fairbanks, Morse Electrical Division, Fairbanks Whitney Corporation	51, 61
Fairbanks Whitney Corporation, Fairbanks, Morse Electrical Division	51, 61
Fawick Corporation, Fawick Airflex Division	203
Federal-Mogul-Bower Bearings, Inc., Bearings Company of America Division	171
Federal-Mogul-Bower Bearings, Inc., Bower Roller Bearing Division	53
Fenwal, Inc.	66
Fornsprag Co.	94, 95

Gamble Brothers, Inc.	90
Garlock, Inc.	115
Gast Manufacturing Corporation	218
General American Transportation Corporation, Parker-Kalon Division	57
General Aniline & Film Corporation, Oxalid Division	92
General Controls Co., Automation Controls Division	177
General Electric Co.	44, 45, 83, 84
General Motors Corporation, New Departure Division	11
General Time Corporation, Hayden Division	79
Gibson Division, Associated Spring Corporation	111
Gillett & Eaton, Inc.	206
Gits Bros. Mfg. Co.	35
Gleason Reel Corporation, Tormag Division	258
Gleason Works	235
Goodrich, B. F., Co., The, Aviation Products Division	219
Goodyear Tire & Rubber Co., The, Industrial Products Division	86, 87
Goshen Rubber Co., Inc.	250
Great Lakes Steel, Division of National Steel Corporation	88, 89
Gries Reproductor Corporation	107

Haloid Xerox, Inc.	223
Hamilton Foundry, Inc.	193
Hamilton Watch Co., Precision Metals Division	180
Hannifin Co., A Division of Parker-Hannifin Corporation	81
Haydon, A. W., Co., The	209
Haydon Division, General Time Corporation	79
Heim Co., The	220
Heinemann Electric Co.	213
Helicoid Gage Division, American Chain & Cable Co., Inc.	251
Hilliard Corporation, The	242
Hitchiner Manufacturing Co., Inc.	244
Hooker Chemical Corporation, Durez Plastics Division	243
Hoover Ball and Bearing Co.	67
Howe Sound Co., Quaker State Metals Co. Division	229
Hubbell, Harvey, Inc.	224
Hunter Spring Co., A Division of American Machine and Metals, Inc.	63, 64
Hydro-Line Manufacturing Co.	2

Illinois Tool Works, Licon Division	247
Imperial Brass Manufacturing Co., The	73
International Basic Economy Corporation, Bellows-Valve Divisions	186

Jack & Heintz, Inc., Commercial Motor Division	205
Johns-Manville	59
Johnson Bronze Co.	262
Johnson, Carlyle, Machine Co., The	181
Jones, Howard B., Division, Cinch Manufacturing Corporation	256

DESIGN

Penton Building, Cleveland 13, Ohio
Main 1-8260

BUSINESS STAFF

ROBERT L. HARTFORD
Publisher
MARY L. CALLAHAN
Advertising Service Manager
RICHARD A. TEMPLETON
Research and Circulation Manager

BARBARA O'LEARY
Staff Assistant

ROBERT E. LESSING
Production Manager

District Offices

New York 17 60 East 42nd St.
RUSSELL H. SMITH, JAMES A. STANGARONE
Murray Hill 2-2581
Simsbury, Conn. 17 Deerfield Lane
ALAN C. BUGBEE
Oldfield 8-4764
Rochester 7 747 East Ave.
EDWARD F. CLANCY
Browning 1-2109
Dresher (Philadelphia), Pa. 1335 Harris Rd.
CHANDLER C. HENLEY
Mitchell 6-2585
Cleveland 13 Penton Bldg.
JACK W. WALTON, DON J. BILLINGS
Main 1-8260
Detroit 35 15800 West McNichols Rd.
Broadway 3-8150
Chicago 11 520 North Michigan Ave.
HOWARD H. DREYER, ROBERT Z. CHEW
DONALD A. IVINS, CHARLES F. REINER
Whitehall 4-1234
Los Angeles 36 5943 West Colgate Ave.
F. J. FULLER
Webster 1-6865
San Francisco 4 57 Post St.
Robert W. Walker Co.
Sutter 1-5568
Birmingham 9 249 La Prado Place
FRED J. ALLEN
Tremont 1-8598
Clearwater, Fla. 1954 Jeffords Dr.
H. G. ROWLAND
(Clearwater) 31-4121
Dallas 35 818 Exchange Bank Bldg.
JAMES H. CASH
Fleetwood 1-4523
London, S.W.1 2 Caxton St., Westminster

Published by

THE PENTON PUBLISHING COMPANY

G. O. HAYS Chairman
R. C. JAENKE President
F. G. STEINEBACH Vice Pres. and Secretary
F. O. RICE Vice President
J. P. LIPKA Vice Pres. and Treasurer
D. C. KIEFER Vice Pres.-Marketing

Also Publisher of

STEEL, FOUNDRY, NEW EQUIPMENT DIGEST,
AUTOMATION

MACHINE DESIGN is sent at no cost to management, design and engineering personnel whose work involves design engineering of machines, appliances, electrical and mechanical equipment, in U. S. and Canadian companies employing 20 or more people. Copies are sent on the basis of one for each group of four or five readers. Consulting and industrial engineering firms, research institutions and U. S. government installations, performing design engineering of products are also eligible.

Subscription in United States, possessions, and Canada for home-addressed copies and copies not qualified under above rules: One year, \$10. Single copies \$1.00. Other countries: One year, \$25. Published every other Thursday by The Penton Publishing Co., Penton Bldg., Cleveland 13, Ohio. Accepted as Controlled Circulation publication at Cleveland, Ohio.



backtalk —

—Our Spencerian Editor

After spending ten years in the miniature world of a watch factory, Spencer Griffith must have regarded the building of an 8¼ by 11¼-in. issue of *MACHINE DESIGN* as a large project. He bravely tackled his first issue in October of 1955.

Spence is a graduate of Lehigh University, with a degree in mechanical engineering. He was elected to two honorary societies while in school and also chose to do extra work, a survey on engineers' salaries, which brought him Special Honors.

Graduation from college also brought Spence a reserve commission in the U. S. Army. He had been on his first job, at Landis Machine Co., less than a year when the Army directed



him to Aberdeen Proving Ground. He served as a supply officer for five years.

When World War II was all, Spence returned to his native Pennsylvania Dutch country, in Lancaster (pronounced LANKaster, please). He went to work at the Hamilton Watch Co. in the watch design section, then advanced to a supervisor of engineering services. He joined *MACHINE DESIGN* as an assistant editor and was made an associate editor in 1956.

—One Each Brickbat & Bouquet

Our jocular comment on this page two issues ago, "engineers are not highly interested in communications," has brought word from two

more readers. The remark, you may remember, was based on: 1. Psychologists' studies of engineers' characteristics. 2. The small number of replies to an invitation to readers to rate themselves on a form printed in a recent article and return the form to us.

One of our epistlers accused us of drawing "incorrect conclusions from (presumably) correct data" and indicated that time (i.e., lack thereof) is the great deterrent in communicating.

The other letter, the one we're saving, explained that its writer didn't fill in and return the form because it would have meant chopping up his copy of the article—which he refused to do.

Incidentally, the article which started all of this (Part I of "The Engineer—Paragon or Paradox?"), plus the other two articles in the same series, plus seven more articles Eugene Raudsepp wrote for *MACHINE DESIGN*, are being assembled into a fine 48-page reprint. Copies can be obtained from Reader's Service Dept., *MACHINE DESIGN*, Penton Bldg., Cleveland 13, Ohio, for \$1.00 each. If you want a copy, there's no need to compose a long, formal letter—just send money.

—Not Only in America

European engineers seems to have the same trouble gaining professional recognition as their American cousins. Addressing a recent meeting of his society, F. A. Flender, chairman of the Association of German Engineers, said that—despite the current importance of technology—the engineer still has difficulty in gaining public interest in his work and problems.

—Need a Hand?

Help for harrassed engineers is provided under a setup called engineering administration. This function, performed by people with a technical background, can save engineers for engineering by freeing them from chores such as keeping records, dealing with personnel and their equipment, preparing maintenance manuals, and keeping files. Read all about it in "Engineering Administration" in the next issue of *MACHINE DESIGN*.

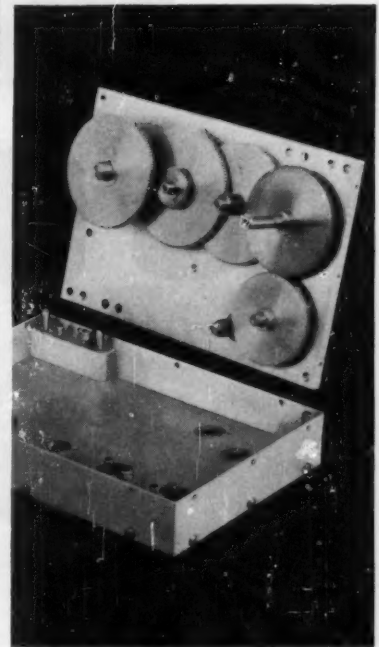
Advertising Index

Jones & Laughlin Steel Corporation, Stainless and Strip Division	36, 37
Joy Manufacturing Co.	82
Lamb Electric Co., The, A Division of American Machine and Metals, Inc.	116
Lee Co., The	238
Lepel High Frequency Laboratories, Inc.	255
Lexington Controls, Inc.	253
Licon, Division of Illinois Tool Works	247
Lincoln Electric Co., The	40, 41
Ling Electronics, A Division of Ling-Altec Electronics, Inc.	174, 175
Link-Belt Co.	49
Lord Manufacturing Co.	60
Malleable Castings Council	102, 103
Manning, Maxwell & Moore, Inc.	91
Manross, F. N., and Sons Division, Associated Spring Corporation	111
Marsh Instrument Co., Division of Colorado Oil and Gas Corporation	210
Meehanite Metal Corporation	97
Metallurgical Products Department of General Electric Co.	188
Metron Instrument Co.	257
Midland-Ross Corporation, Waldron-Hartig Division	232
Midvale-Heppenstall Co.	9
Milwaukee Division, Associated Spring Corporation	111
Minnesota Mining and Manufacturing Co., Adhesives, Coatings and Sealers Division	237
MPB, Inc., Split Ballbearing Division	196
National Broach & Machine Co.	254
National Lock Washer Co., The	178
National Malleable and Steel Castings Co.	110
National Screw & Mfg. Co., The	108
National Steel Corporation, Great Lakes Steel Division	88, 89
New Departure, Division of General Motors Corporation	11
New Hampshire Ball Bearings, Inc.	104
Nosco Plastics, Inc.	62
Nylogrip Products	255
Ohio Division, Associated Spring Corporation	111
Ohmite Manufacturing Co.	38
Oilgear Co., The	7
Ozolid, Division of General Aniline & Film Corporation	92
Palnut Co., The, Division of United-Carr Fastener Corporation	234
Parker-Hannifin Corporation, Hannifin Co. Division	81
Parker-Kalon, Division of General American Transportation Corporation	57
Pathon Manufacturing Co.	208
Peerless Electric Division, H. F. Porter Co., Inc.	24
Perfecting Service Co.	257
Philadelphia Gear Corporation	52
Plastic and Rubber Products Co.	231
Poly Chem	230
Polymer Corporation, The, Molding Resins Division	239
Pope Machinery Corporation	80
Porter, H. K., Co., Inc., Peerless Electric Division	24
Post, Frederick, Co.	15
Precision Castings Co., Division of Precasco Corporation	46, 47
Precision Metals Division, Hamilton Watch Co.	180
Precision Tube Co., Inc.	210
Quaker State Metals Co., A Division of Howe Sound Co.	229
Raybestos-Manhattan, Inc., Equipment Sales Division	71
Raymond Manufacturing Division, Associated Spring Corporation	111

Reliance Electric and Engineering Co.	192
Robbins & Myers, Inc.	184
Rockford Clutch Division, Borg-Warner Corporation	221
Rockwell-Standard Corporation, Transmission and Axle Division	101
Roper Hydraulics, Inc.	228
Ross Operating Valve Co.	1
Schrader's, A. Son, Division of Scovill Manufacturing Co., Inc.	96
Schutte and Koerting Co., Instrument Division	256
Scovill Manufacturing Co., Inc., A. Schrader's Son Division	96
Seaboard Pacific Division, Associated Spring Corporation	111
Servospeed, Division of Electro Devices, Inc.	224
Sierra Engineering Co.	254
Simplatrol Products Corporation	254
Smith, A. O., Corporation	178
South Chester Corporation, Southco Division	85
Spectral Electronics Corporation	222
Sperry Rand Corporation, Vickers, Inc., Machinery Hydraulics Division	215
Split Ballbearing, A Division of MPB, Inc.	196
Stackpole Carbon Co.	217
Standard Instrument Corporation	253
Standard Pressed Steel Co., Industrial Fastener Division	48
Standard Screw Co.	233
Stow Manufacturing Co.	236
Stratoflex, Inc.	240
Superior Tube Co.	225
Technical Development Co.	204
Timken Roller Bearing Co., The, Steel and Tube Division	21
Tinnerman Products, Inc.	118
Torrington Co., The	13
Torrington Manufacturing Co., The	117
Townsend Co., Engineered Fasteners Division	195
Transmission and Axle Division, Rockwell-Standard Corporation	101
Triangle Manufacturing Co.	256
Trostel, Albert, Packing, Ltd.	200
Tubular Rivet & Stud Co.	252
Tuthill Pump Co.	78
United Aircraft Products, Inc., United Metallic "O" Ring Division	204
United-Carr Fastener Corporation, The Palnut Co. Division	234
United Metallic "O" Ring Corporation, Division of United Aircraft Products, Inc.	204
United States Graphite Co., The, Division of The Wickes Corporation	98, 99
United States Rubber, Mechanical Goods Division	50
Valley Electric Corporation	212
Valvair Corporation, Division of International Basic Economy Corporation	186
Versa Products Co., Inc.	258
Vickers, Inc., Division of Sperry Rand Corporation, Machinery Hydraulics Division	215
Victor Mfg. & Gasket Co.	112
Wagner Electric Corporation	106
Waldron-Hartig Division, Midland-Ross Corporation	232
Weatherhead Co., The, Fort Wayne Division	70
Westinghouse Air Brake Co., Industrial Products Division	245
White, S. S., Industrial Division	241
Whitney Chain Co., The	199
Wickes Corporation, The, The United States Graphite Co. Division	98, 99
Wiley, John, & Sons, Inc.	256
Wilkinson Corporation	39
Wood's, T. B., Sons, Co.	42, 43
Engineers Available or Wanted	258

PROGRAMMING FOR PRECISION

Precision is the prerequisite for meeting the ever increasing demands of this challenging age of Instrumentation and Automation. You will find the classical solution to your precision design and manufacturing problems at H.O. Boehme, Inc.



The gear train shown represents a typical Boehme answer to a specific precision problem.

We have set precision standards in custom-made gear design, engineering, and manufacture for over three decades. We will supply all your custom-made fine pitch precision gear needs—from $\frac{1}{8}$ " to 5" O.D., 180 to 16 D.P., up to A.G.M.A. Precision #3—or to specifications named by you.

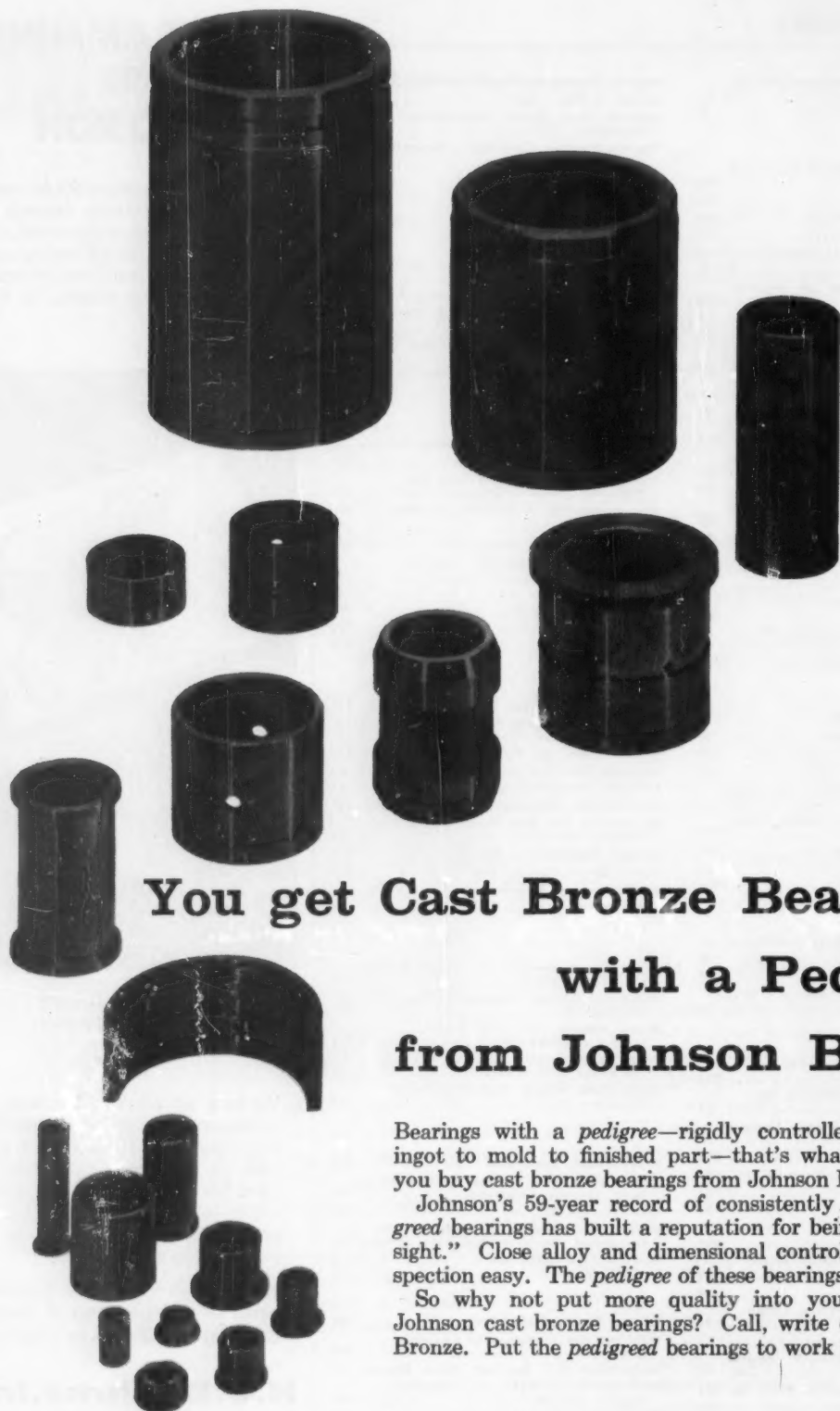
Your inquiries are welcome. Estimates based on your blueprints or sketches will be furnished, at no obligation.

H.O. Boehme, Inc.

Contractors, Designers, Manufacturers
of Precision Electrical, Electro-
Mechanical and Electronic
Equipment since 1917



915 Broadway
New York 10, N. Y.



You get Cast Bronze Bearings with a Pedigree from Johnson Bronze

Bearings with a *pedigree*—rigidly controlled quality from ingot to mold to finished part—that's what you get when you buy cast bronze bearings from Johnson Bronze Co.

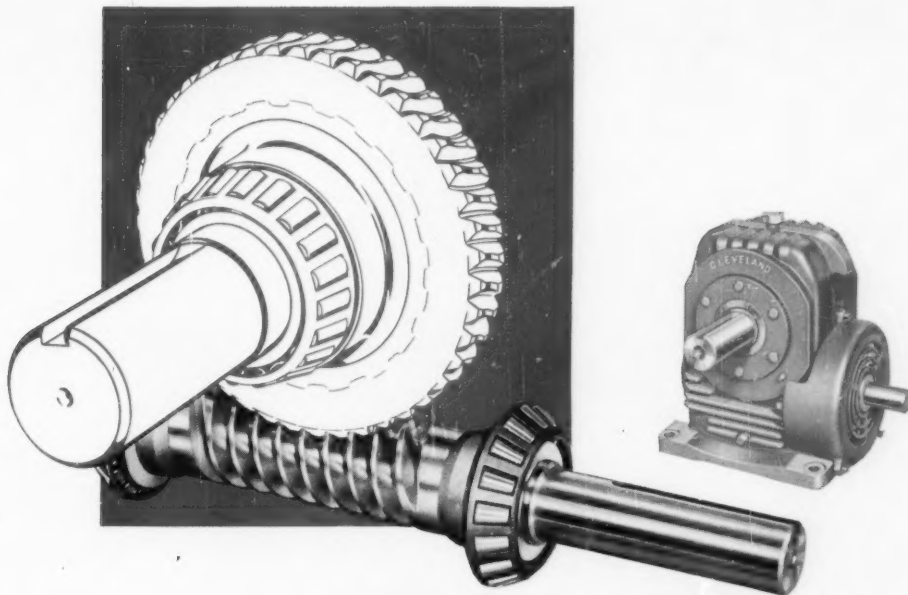
Johnson's 59-year record of consistently supplying *pedigreed* bearings has built a reputation for being "accepted on sight." Close alloy and dimensional control make your inspection easy. The *pedigree* of these bearings tells you why.

So why not put more quality into your product with Johnson cast bronze bearings? Call, write or wire Johnson Bronze. Put the *pedigreed* bearings to work for you.

Johnson Bronze Company

New Castle, Pa.

West Coast Plant: Oakland 8, Calif.



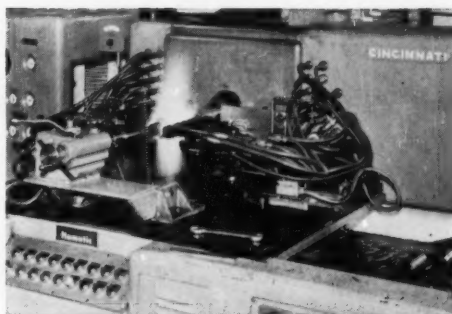
Flamatic-hardened worms help give Cleveland Speed Reducers their longer service life . . .

On all Cleveland Speed Reducers, alloy steel worms are cut integral with the shaft and accurately ground to a high surface finish on both thread flanks. Shaft extension diameter is especially large to permit increased overhung load capacity. Heat treating is by means of an acetylene-oxygen flame at 3300° F.—exclusive with Cleveland-made worms. This provides a high degree of hardness throughout the entire thread thickness and well below the worm's root diameter—(See etched worm cross-section).

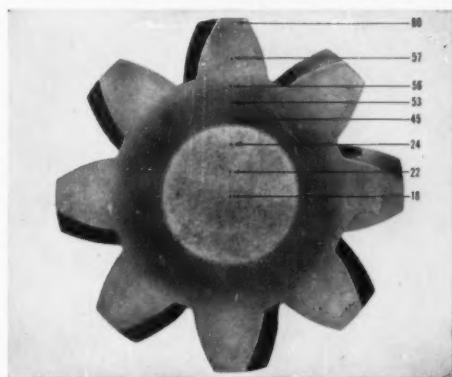
This new worm hardness pattern gives maximum thread strength and resistance to wear without sacrificing the advantage of a medium-hard tough core. Furthermore, the pattern is carried out in the worm shaft extension past the oil seal wearing surface to prevent the shaft being worn and damaged by its oil seal.

Mated with Cleveland's high density centrifugally cast bronze gears, the result is increased wear resistance—much longer trouble-free service life.

Why not write today for your free copy of Bulletin No. 405 showing the latest developments in the Cleveland Worm Gear Line. Or, better yet, contact your nearest Cleveland Representative and get the complete facts.



Worms are Flamatic-hardened in the Cleveland Plant (above) to give them the typical Rockwell "C" hardness pattern as shown in the etched cross-section (below).



Cleveland Worm & Gear Division
Eaton Manufacturing Company
3287 East 80th Street • Cleveland 4, Ohio



**Look what's behind
Cutler-Hammer's
new trademark**



You can see the new power at Cutler-Hammer wherever you look. New products. New engineering depth, particularly in industrial automation. New plants and streamlined marketing methods, too. Even a new trademark to reflect this new vitality.

If you're planning ahead for the great growth of the sixties, come to the company that's ready to plan ahead with you. Look at just a few of the new products that are already improving efficiency in many fields:

NEW computer system for establishing quality of tinplate coils

NEW limit switch that outlasts others by at least two times

NEW automated system for charging blast furnaces in steel mills

NEW stacker that counts and stacks newspapers automatically

NEW Safetybreaker line of service entrance equipment

WHAT'S NEW? ASK...

CUTLER-HAMMER

Cutler-Hammer Inc., Milwaukee, Wis. • Division: Airborne Instruments Laboratory • Subsidiary: Cutler-Hammer International, C. A. Associates: Canadian Cutler-Hammer, Ltd.; Cutler-Hammer Mexicana, S. A.; Intercontinental Electronics Corporation.



